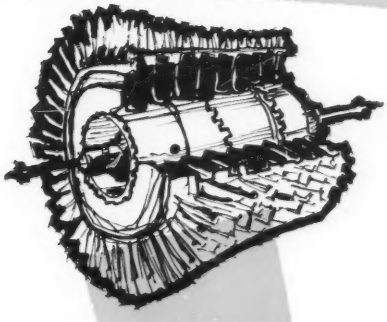
Design Engineering



A LONG ROAD TO SIMPLICITY . . .

April 1955

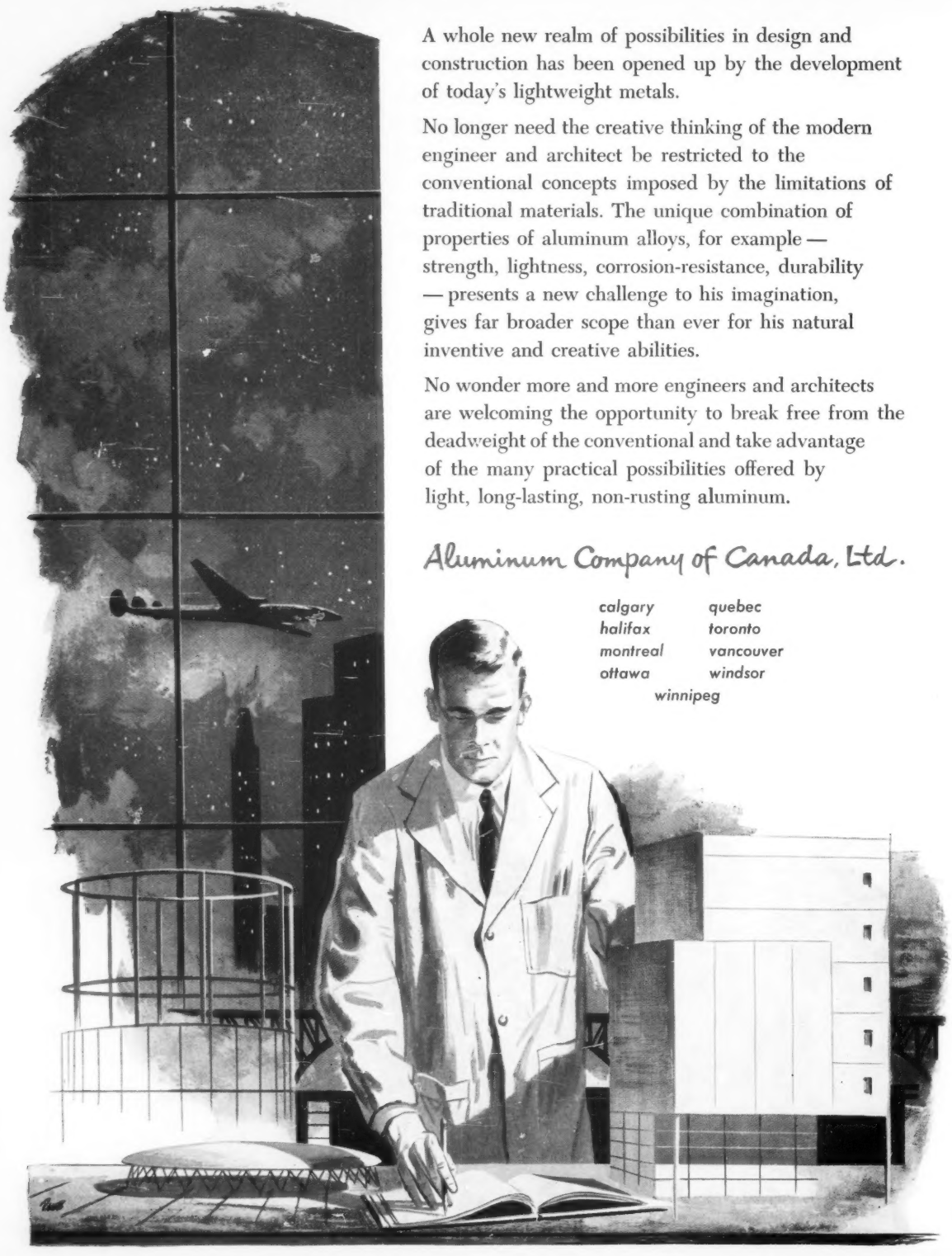
Could Canada's jet engine be simpler?

What is your isocyanates I.Q.?

Let a pulse search out the defect!

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY LIMITED, TORONTO, CANADA

Breaking free from the fetters of convention



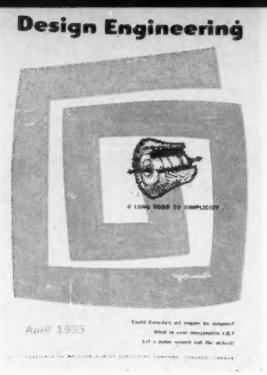
A whole new realm of possibilities in design and construction has been opened up by the development of today's lightweight metals.

No longer need the creative thinking of the modern engineer and architect be restricted to the conventional concepts imposed by the limitations of traditional materials. The unique combination of properties of aluminum alloys, for example — strength, lightness, corrosion-resistance, durability — presents a new challenge to his imagination, gives far broader scope than ever for his natural inventive and creative abilities.

No wonder more and more engineers and architects are welcoming the opportunity to break free from the deadweight of the conventional and take advantage of the many practical possibilities offered by light, long-lasting, non-rusting aluminum.

Aluminum Company of Canada, Ltd.

calgary *quebec*
halifax *toronto*
montreal *vancouver*
ottawa *windsor*
winnipeg



This month's cover

When Canadian artist Don Dancer was asked to convey the fight for simplicity in jet engine design (page 31) for **Design Engineering's** first cover, he came up with 24 roughs. The editors, appalled by the complexity of their own problems in choosing, finally went for the one showing a long, twisted trail with an Orenda compressor rotor at its end. The reasoning? There are few straight paths today that lead to mechanical simplicity.

Design Engineering

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Design Engineering

VOLUME 1 **APRIL 1955** NUMBER 1

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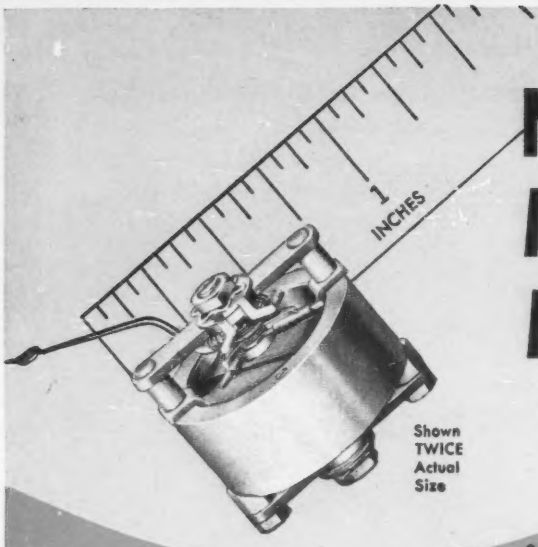

Shown TWICE Actual Size

New Simpson Magnetic Core Movement

Made In Canada

Rugged . . . yet built like a fine watch!

Here's the new Simpson ***Magnetic Core Meter Movement.*** It's a more compact, more sensitive, ***self-shielding*** movement that gives electrical measurements with laboratory accuracy, yet has the ruggedness to withstand severe shocks. Its accuracy specifications are so rigid that Simpson engineers had to devise unusual production techniques.

Let Simpson engineers design panel meters using the new core movement to your special instrument requirements. Simpson continues to lead with its large selection of standard panel meters in over 700 sizes and ranges, available through distributors.

RUGGEDIZED METERS

Simpson's 2½" and 3½" Panel Meters are available in ***sealed, ruggedized*** models to meet specifications JCNAAF-M-36. Movements are sealed against moisture and other adverse atmospheres, with a moving coil system, spring mounted to absorb excessive vibration.

INSTRUMENTS THAT STAY ACCURATE

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Design Engineering

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Editorial correspondents in: The United Kingdom, the United States, Germany, France and Italy.

The May issue of **Design Engineering** will carry strong articles written by contributors no less skilled than those featured on this month's pages.

Torsional vibration in piston engines will be the lead feature contributed by a specialist engineer.

Automobile finishes — the subtle art of protecting while glamorizing — will also be explored in a full-length exclusive feature.

Then, isotopes. What do you know about modern thinking on isotopes? The latest information will be brought to you in May's **Design Engineering.**

Special Artwork
Editorial layouts designed by art consultant **Desmond English.**

Avery

POSSIBLY BECAUSE HE is only 33, Orenda's chief design engineer **B. A. (Bert) Avery** has taken an anxious look at the future. He sees trouble ahead from the flux of accessories — "the tremendous trifles" — making modern jet engines too complex. He writes about the struggle for simplicity (page 31) behind Canada's famous Orenda. He is a graduate engineer, started work on jets in 1946, has enjoyed some very quick promotions. His article suggests why.

Marco

NON DESTRUCTIVE TESTING is one of the more complex subjects. **M. J. Marco,** vice-president, Non-Destructive Testing Corp., discusses ultrasonics (page 36). A graduate of the UBC, he is confident enough of his story to have said: "This I must send to my old professor." His is the first of several stories on testing that are coming.

Ness

A CANADIAN BORN in Scotland, is how the writer on Fiberglas plastic (page 40) **Charles W. Ness** describes himself. When asked to write about this modern material he agreed quickly, then added: "But I'm warning you. When I get going I fill a whole book."

As a graduate metallurgical engineer, good conversationalist and long-time expert in Fiberglas who was with it "from its first faltering steps" (in 1945), he is uniquely qualified to talk of plastics for today.

Gilson

WHEN THE FAMOUS Kitimat contracts were running, **W. J. Gilson,** president of Eastern Power Devices, fought the ruling (imported from the U. S.) that 7-in. bolt circle insulators should be used. He won—and 5-in. insulators were approved at big savings. He has just repeated the fight this time with the St. Lawrence Bersimis contract. He is known as a radical in industry. His own description: "I just like to paddle my own boat." He writes about circuit breaker design (page 50) in this issue.

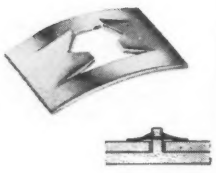
Chatterton

THE ISOCYANATES STORY (page 44) is told under an assumed name by a coatings specialist who is also a professional writer. Only by keeping his name secret can he stay free, he feels, to write frankly about products in harsh competition with each other. "**Frank Chatterton**" is anxious for readers to know he is not on the run.

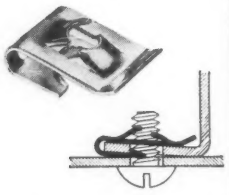
design SAVINGS into your product

with TINNERMAN Speed Nuts®

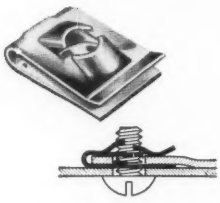
FLAT TYPE — One-piece self-locking spring steel fasteners. Replace threaded nuts, lock washers or spanner washers. Available in a wide variety of shapes and screw sizes.



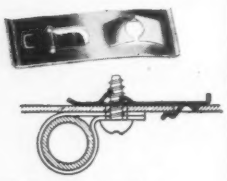
PUSH-ON — Zip over unthreaded die cast or plastic studs, rivets, nails, tubing, or wire to lock parts securely. Removable types available in many sizes.



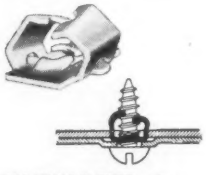
"J" TYPE — Snap over edge of panels and into center hole locations. Hold themselves in place for blind assembly. Full range of panel thicknesses and screw sizes available.



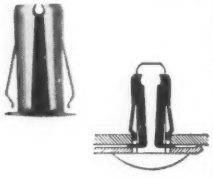
"U" TYPE — Perform same function as "J" type for reduced materials handling. Used where full bearing on lower leg of the Speed Nut is required.



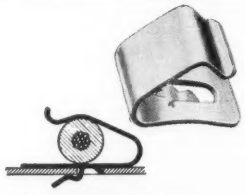
LATCH TYPE — Easily applied by hand, are self-retained in bolt-receiving position at center panel locations for blind attachments. Front mounting types are also available.



EXPANSION TYPE — For lightning-fast attachments in blind locations. Snap into mounting holes by hand. Screw spreads spring fingers, wedge-locks part in position. Secure, vibration-proof attachment.

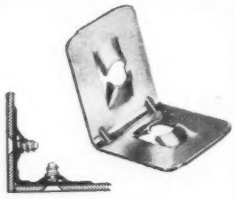


TUBULAR CLIPS — For use with unthreaded studs or rivets. Virtually "nails" panels together where there is access to one side only. Permanent lock or removable types.

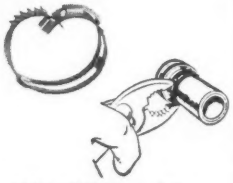


CABLE, WIRE, AND TUBE RETAINERS — Snap in place by hand, self-retained in position to receive wide range of cable, wire and tube sizes. Easily removed for service or re-location.

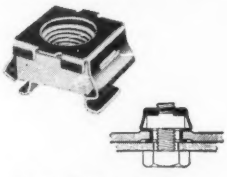
HARNESS CLAMPS — Open or close by hand — no tools needed. Attach to panel or pre-assembly to harness before installation. Cushioned to protect wires. Cannot open accidentally.



ANGLE BRACKETS — Combine bracket and fastener to reduce number of parts, speed up assembly and strengthen the structure. Variety of shapes and sizes.



HOSE CLAMPS — Self-locking, ratchet-type design, one-piece low profile construction — no bolts, nuts or thumb screws. Fast and easy to apply and remove for medium- and low-pressure connections.



NUT RETAINERS — Retain square nuts in blind locations. No welding, clinching, staking — snap in by hand. Provided in a wide range of screw sizes. "U" and "J" type retainers available.

A fastener is an important part of any product. Careful study and analysis of its design and function can greatly improve product quality and lower the over-all production costs. The Speed Nut method of fastening has provided an economical and efficient solution to countless attachment problems. There are more than 6,000 types and sizes of Speed Nut fasteners available for your needs. If necessary a new fastener can be engineered to suit your requirements. Write today for the full Speed Nut story.

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Branches: Toronto, Montreal

EXCLUSIVE CANADIAN MANUFACTURER and LICENSEE

Reports

News in brief from the world's producers

A RECORD AWARDS TOTAL of $27,000 went to employees of Canadian General Electric Co., during 1954 for 1,761 useful suggestions adopted under the company's suggestion award program.

Top award winner was **Mary Gurnick** of the Radio & Television Department. She collected $532 for one idea.

• • •

SHOWING A MANUFACTURER how their equipment can handle this work, and even quoting him machine time on parts, is the idea behind A. C. Wickman's **"Showroom in Motion,"** an extension of the company's Toronto plant. First in Canada with this selling idea, customers will see the solution to manufacturing problems shown on machines before a purchase order is given.

• • •

Saul Poliak changes his mind

THE FIRST CONFERENCE specially aimed at design engineers was to be run in Philadelphia, May 31, by American management firm Clapp and Poliak. Now Saul Poliak, (president) has postponed it a year. "It was impossible to get the right caliber of speaker at short notice," he explained.

But next year it will run as the **Design Engineering Show** and succeed the Basic Materials Exposition, held previously in New York and Chicago.

Although many of the features of the Basic Materials Exposition will be retained, emphasis will now be placed on design engineering rather than on basic materials only. For example, mechanical, electrical, hydraulic and pneumatic components of end products, finishes, coatings and other parts, shapes and forms will be featured along with materials. These materials will include all the metallic (and their various alloys) as well as the non-metallic materials.

• • •

CANADIAN STANDARDS COMMITTEE held a meeting on magnesium alloys in Ottawa recently. Mr. H. G. Warrington of Dominion Magnesium Ltd., committee chairman, presided. The object of the meeting was to study the **first draft of proposed CSA specifications** for magnesium and its alloys.

• • •

THE INTERNATIONAL NICKEL CO., of Canada made the first shipment of approximately **450,000 lb. of refined nickel** to the General Services Administration of the United States Government under a contract signed between the company and the government agency last fall, providing for refining of certain nickel concentrate produced by Sherritt Gordon Mines Ltd.

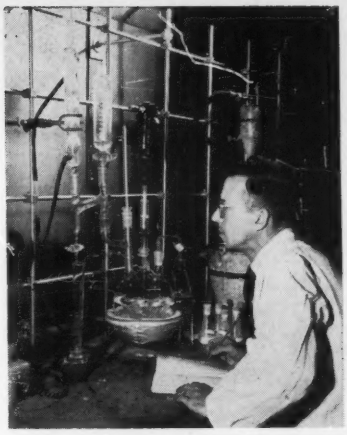
The contract called for delivery of a minimum of 4,500,000 lb. of refined nickel in the period ending August, 1955. Because of improved methods for treating this concentrate it will be possible to increase deliveries beyond the contract minimum, the company now expects.

• • •

TCA HAVE A $17 MILLION ORDER for a fleet of 22 Rolls-Royce Dart-powered **Vickers Viscount** turbo-prop aircraft. Some of these will be in service by the beginning of this month.

The Viscount has cabin accommodation for 48 passengers in 12 rows of four abreast seats. There is a flight crew of two and two hostesses.

The fuel they will use is not kerosene but a so-called wide-cut gasoline from a number of Canadian refineries.



CIL builds a bigger lab

CIL'S RESEARCH LABORATORY in Toronto is having over 15,000 sq. ft. added to its existing 17,000 sq. ft. of floor space.

By nearly **doubling its size** the laboratory will get a new weatherometer room, spray room and luxurious testing space for studying automotive finishes, industrial and domestic paints and materials and a library.

The addition runs three-stories high. When it goes into use (probably June of this year) the staff strength will be stepped up from 62 technicians to 125.

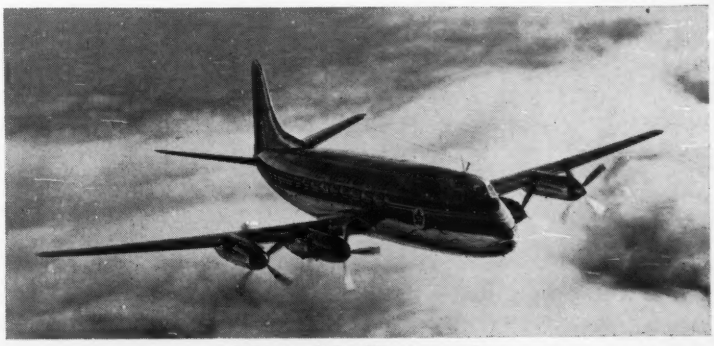
The expansion has come quickly. It is only two years ago that the original part of the laboratory was built.

• • •

WORK HAS BEGUN on the first full-scale isocyanates (page 38) production plant, states **David L. Eynon,** President of the Mobay Chemical Co.

The plant is expected to be operating in about twelve months. It will produce each month several hundred tons of isocyanate chemicals, with equivalent amounts of polyester resins.

Mobay will not make any finished goods but will supply resins, activators, modifiers, catalysts and other chemicals. It will also offer technical know-how and the machinery for producing foam to industry. The company is owned by Monsanto and Farbenfabriken Bayer.

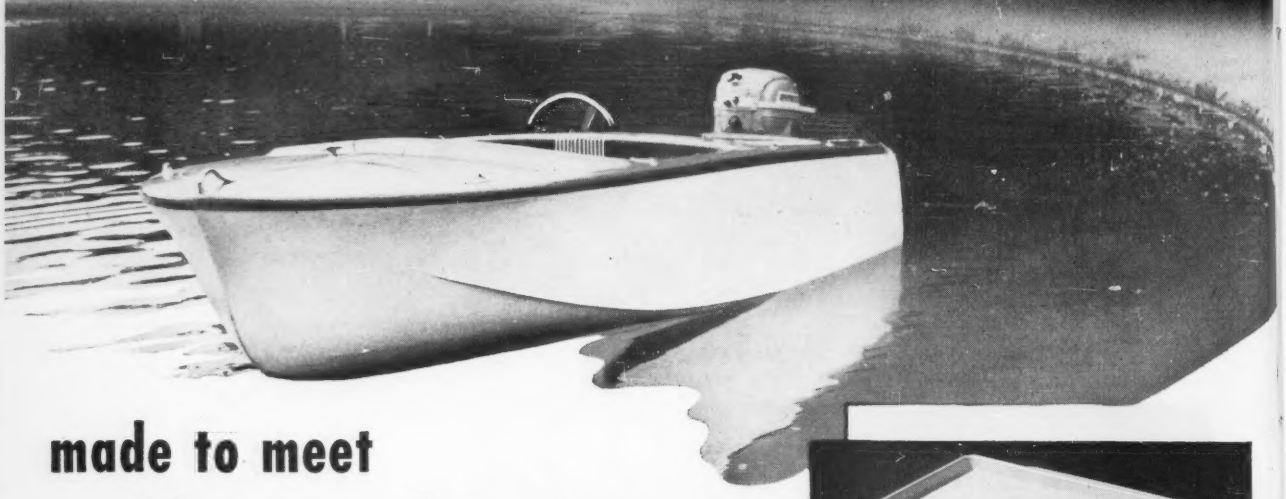


TCA has $17 million to spend

BAKELITE

TRADE-MARK

Polyester Resins



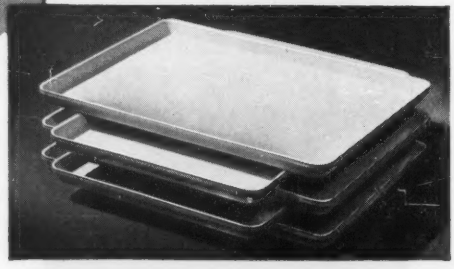
made to meet a wide range of requirements

There are many applications of reinforced plastics today, and in the very near future there will be many more. The products illustrated on this page give an idea as to the variety of characteristics available with BAKELITE Polyester Resins; corrosion resistance, thermal and electrical insulation, high strength-weight ratio, adaptability to fabrication into large sections, economy through low-cost tooling, excellent water resistance, as well as resistance to many chemicals, heat and cold.

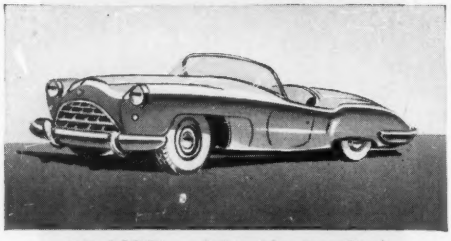
BAKELITE Company engineers worked very closely with Canada Moulders Incorporated, Montreal, in developing the boat shown above—it is seamless moulded in one piece and designed to provide maximum safety, top performance and long life. The color is moulded right into the hull and deck.

The products to the right are produced by MRF Canada Limited, Montreal, using BAKELITE Polyester Resins.

The growing list of uses may soon include your product—for full information telephone or write



TRAYS—will not crack, dent, chip or distort, are lightweight for easy handling and available in long lasting, attractive colors



CAR BODIES — lightweight, streamlined sports cars moulded with BAKELITE Polyester Resins are opening up an entirely new industry in Canada.

PERMANENT SIGNS—never require painting or maintenance, unaffected by weather and will not rust or deteriorate in any way.

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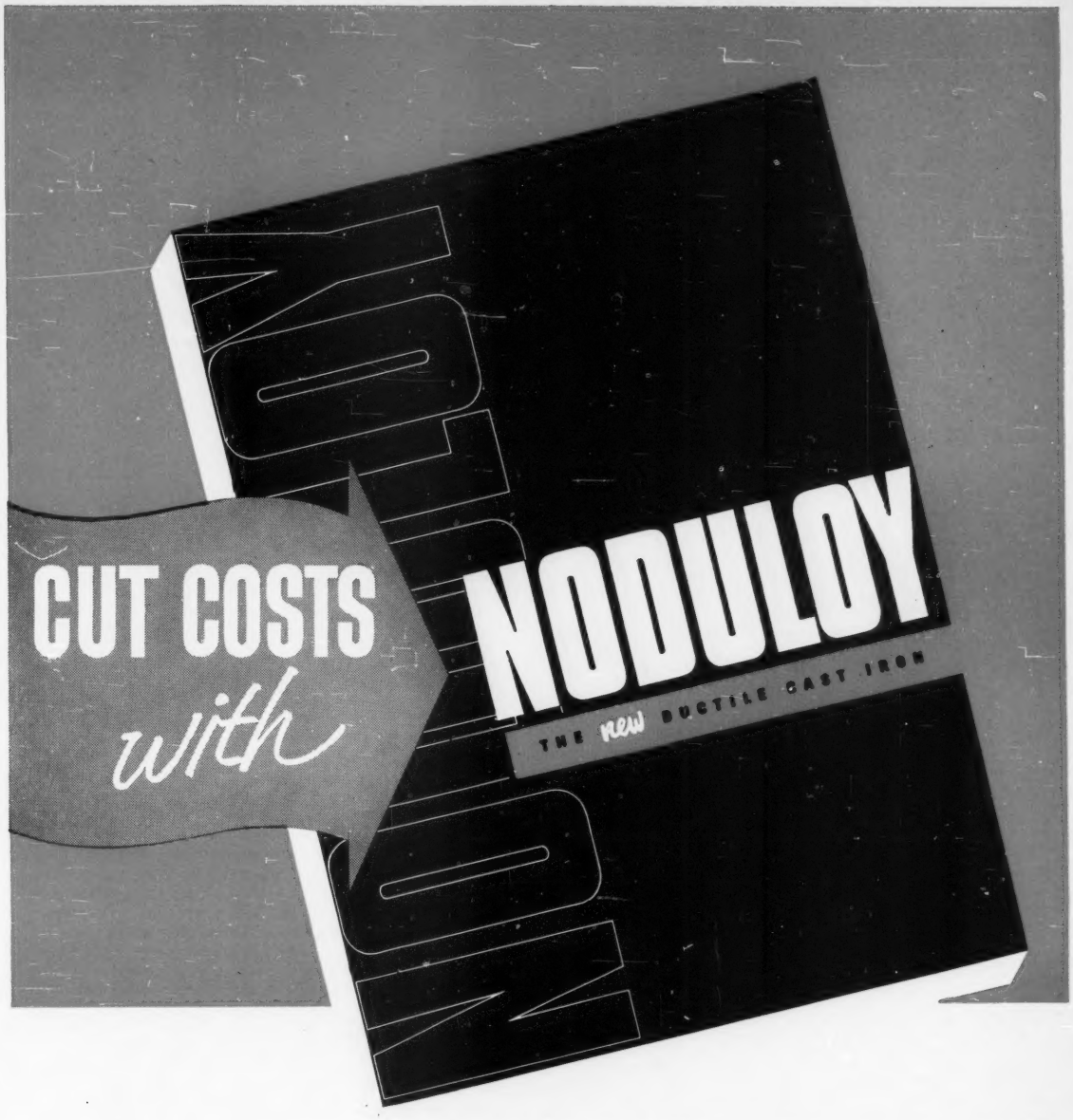

For very special jobs, and for regular jobs you want to do better, you'll find Noduloy worth investigation. Machine designers are discovering that Noduloy is an excellent replacement for more costly materials. Tool designers are taking advantage of the properties of Noduloy and using it where cast metal is desirable and ordinary cast iron is impractical.

Write to-day for this interesting book on amazing Noduloy—the ductile cast iron of a thousand applications.

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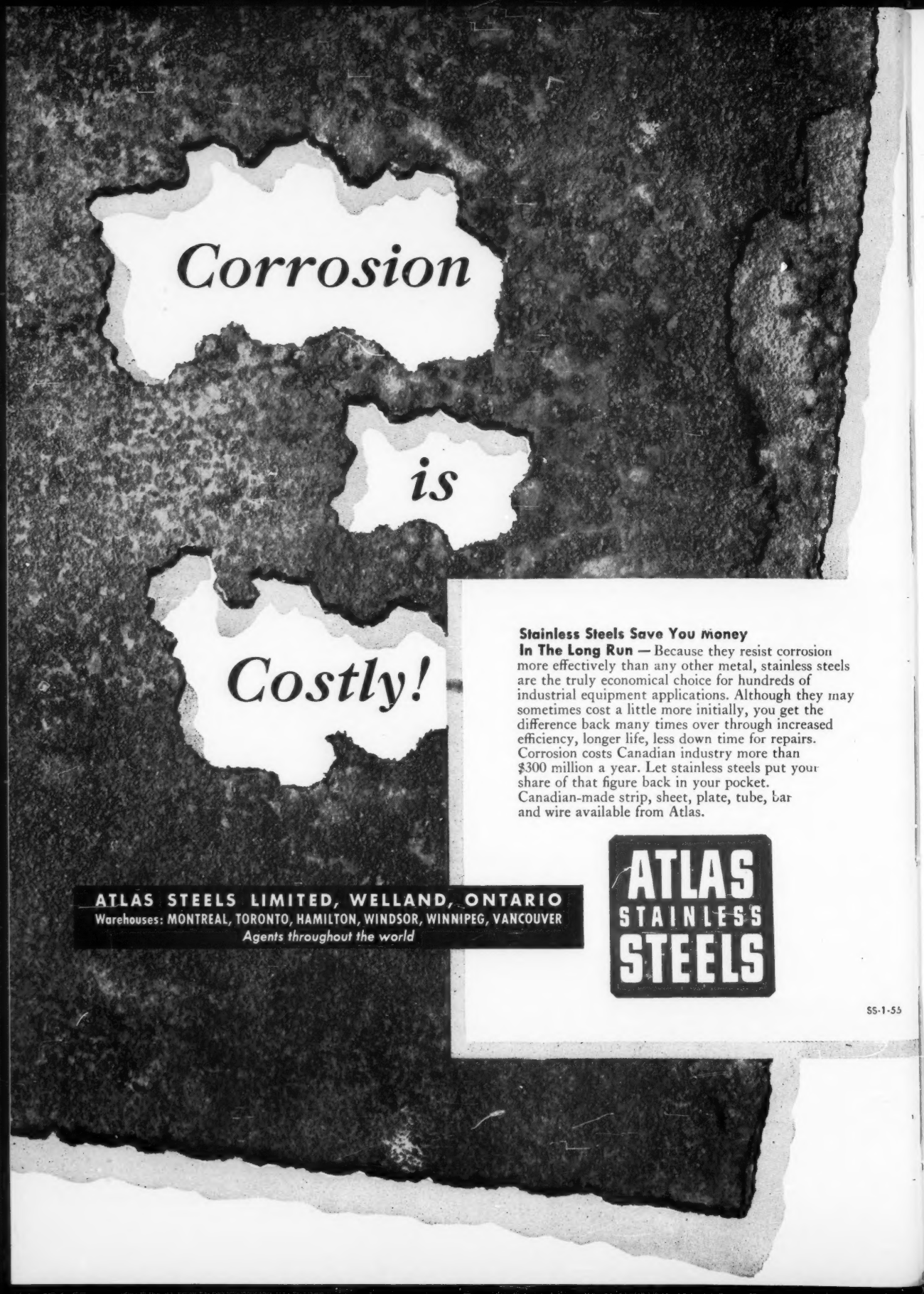
Corrosion
is
Costly!
Stainless Steels Save You Money
In The Long Run — Because they resist corrosion more effectively than any other metal, stainless steels are the truly economical choice for hundreds of industrial equipment applications. Although they may sometimes cost a little more initially, you get the difference back many times over through increased efficiency, longer life, less down time for repairs. Corrosion costs Canadian industry more than $300 million a year. Let stainless steels put your share of that figure back in your pocket. Canadian-made strip, sheet, plate, tube, bar and wire available from Atlas.
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SS-1-55

T.V. CHANGES THE PICTURE —SO DOES FORGING

T.V. has radically changed the outlooks and leisure habits of North American families in the last decade. Through this new media, people are more informed about world events . . . have better entertainment.

In the metal industry too, great changes have taken place. One of the most important is the improvement of metals through *quality forging*. Not only physical shape, but the entire structure of the metal is changed. Each fibre is forced to follow the shape of the forging—giving the finished product immense uniform strength. As with television, precision forging takes a great deal of know how, plus highly skilled men with complete facilities at their disposal. That's why the Canadian Government went to the top forging plant in Canada. They asked CANADIAN STEEL IMPROVEMENT LTD., foremost in the field, to forge the jet compressor blades and turbine buckets for jet engines.

It was a tricky job—working with high temperature alloys and taking them to precision tolerances. It took expert engineering, careful laboratory testing of raw materials, precision-tolerance forging, and rigidly high standards of inspection.

The result was a better, stronger product at lower cost—compared to other possible methods of production.

But that is just one example! C.S.I. top-drawer services and modern, money-saving techniques are available to you. No matter what your product is, take it to C.S.I. See if it can't be forged—better!

5503

CANADIAN STEEL IMPROVEMENT LIMITED

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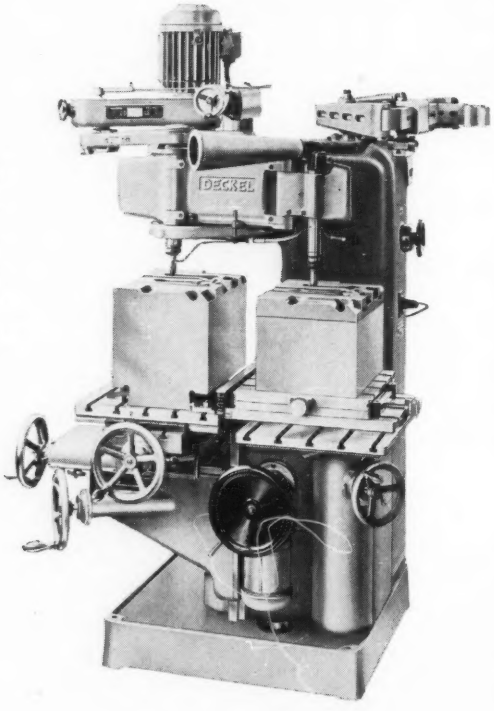
Alloy and Stainless Steels • High Temperature Alloys • Titanium • Aluminum

DESIGN ENGINEERS

PRECISION TOOLS

DECKEL

Design and methods engineers in Canada can eliminate many design problems by a knowledge of the diversified possibilities obtained with Deckel equipment.



Rough Milling with the aid of the Optical Contacting Device on the Universal Pantograph Die Sinking Machine Type KF 12

MANUFACTURING —

UNIVERSAL LETTER ENGRAVING MACHINES G

UNIVERSAL PANTOGRAPH ENGRAVING & PROFILING MILLERS, GK

UNIVERSAL PANTOGRAPH DIE SINKING MACHINES KF

UNIVERSAL TOOL MILLING MACHINES FP

UNIVERSAL TOOL & CUTTER GRINDER S1

SINGLE LIP CUTTER GRINDER S0

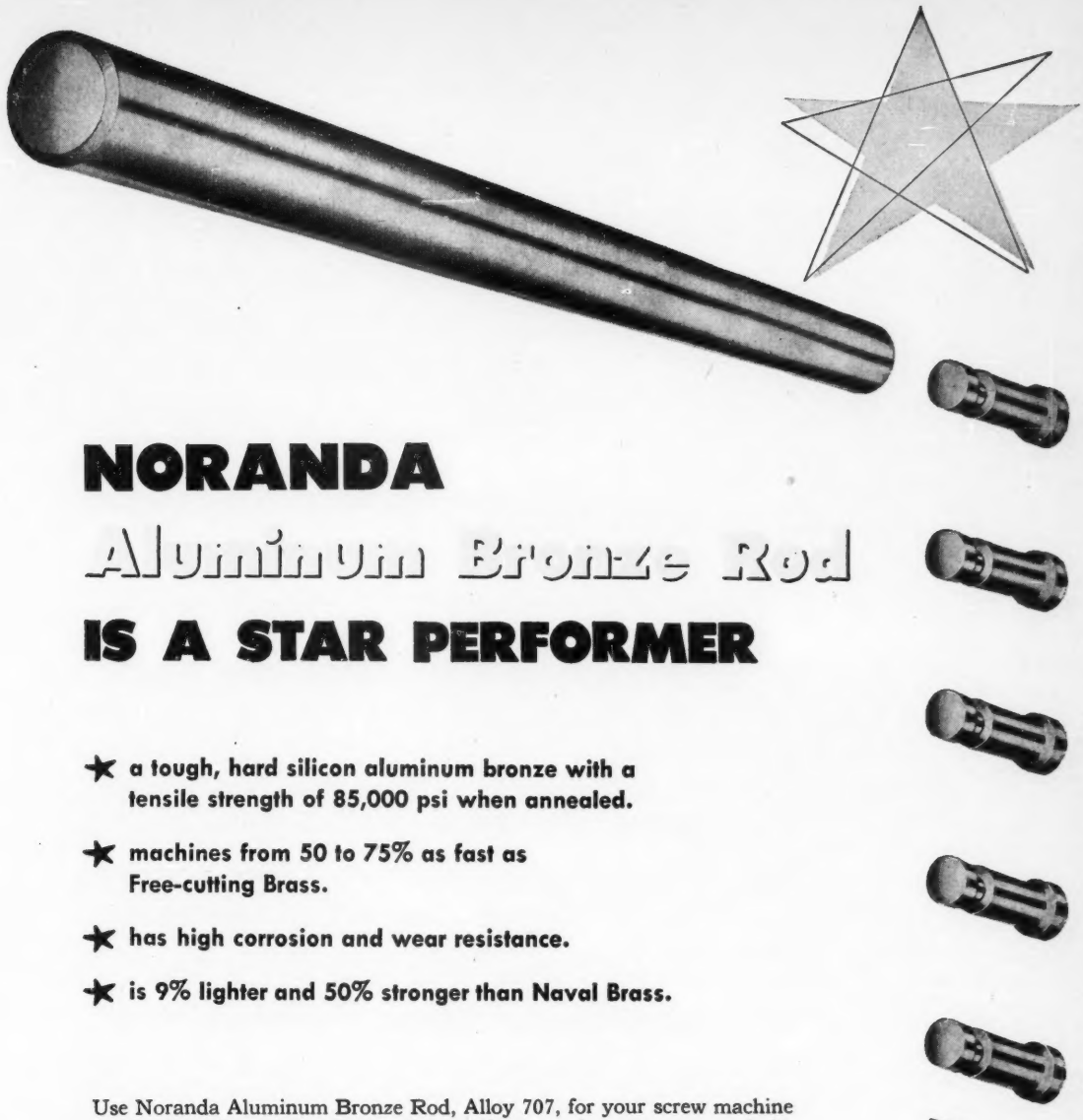
Write For Further Details

COSA CORPORATION OF CANADA LIMITED

40 Front St. West **TORONTO**
1191 University St. **MONTREAL**
46 Elgin St. **OTTAWA**

COSA

Associated Offices throughout the world



NORANDA

Aluminum Bronze Rod

IS A STAR PERFORMER

- **a tough, hard silicon aluminum bronze with a tensile strength of 85,000 psi when annealed.**
- **machines from 50 to 75% as fast as Free-cutting Brass.**
- **has high corrosion and wear resistance.**
- **is 9% lighter and 50% stronger than Naval Brass.**

Use Noranda Aluminum Bronze Rod, Alloy 707, for your screw machine production of marine and pole line hardware, valve stems, nuts, bolts and other parts where *high strength, corrosion resistance* and *machinability* are *musts*.

Contact your nearest Noranda Sales Office for complete information on Noranda Aluminum Bronze Rod, Free-cutting Brass Rod and other Noranda Alloys made to meet a variety of screw machine applications and give you more economical production. Ask our Sales Office to tell you about Noranda's Technical Service to help you solve metals and methods problems.

Write for your copy of the Noranda Technical Handbook which contains helpful data on Aluminum Bronze and other high-strength alloys.

NORANDA COPPER AND BRASS LIMITED

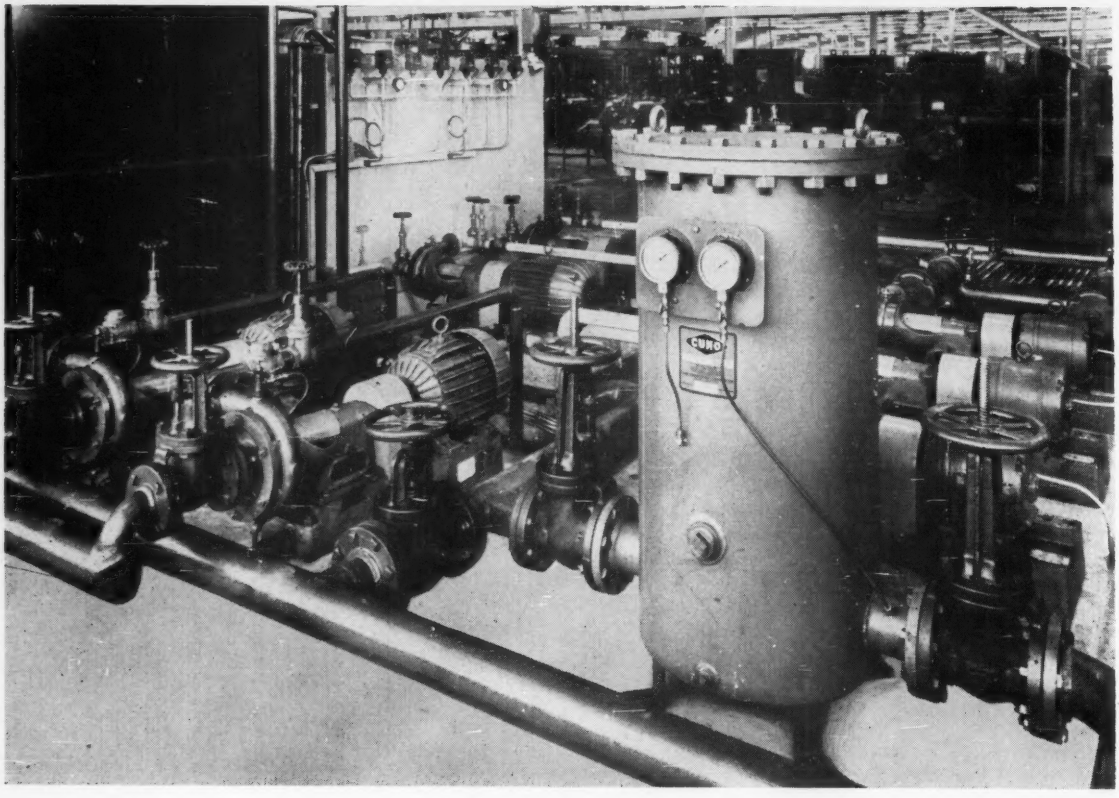
Mills at Montreal East—Quebec, Canada

Sales Offices: Montreal, Quebec; Toronto and Windsor, Ontario; Edmonton, Alberta; Vancouver, B.C.

Noranda is the Reliable Source for all Brass Mill Products

CUNO

MICRO-KLEAN FILTERS PLAY THEIR PART IN CANADA'S AUTOMOTIVE INDUSTRY



Cuno Micro-Klean water filter on test beds for completed engines in one of Southern Ontario's largest automobile plants.

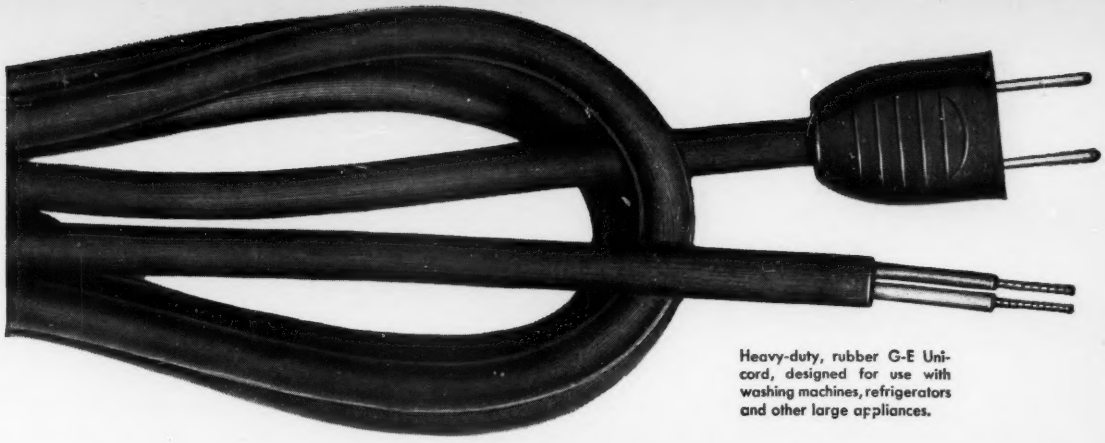
This Model 30D3 Micro-Klean filter will remove *all* solid contaminants down to the rated size of the cartridges and a large percentage of particles down to one micron in size. When fitted with 50 micron cartridges it has a capacity of 900 U.S. gals. per min., 25 micron cartridges give it a capacity of 660 U.S. gals. per min. and 10 micron cartridges a capacity of 330 U.S. gals. per min.

Micro-Kleans are also widely used on paint spray, dip tanks, coolants, fuel, lube and hydraulic oils. For further information, write to Peacock Brothers Limited, P.O. Box 1040, Montreal—Canadian Representatives of The Cuno Engineering Corporation.

PEACOCK BROTHERS LIMITED

Montreal

Sydney Toronto Sudbury Winnipeg Edmonton Calgary Vancouver



Heavy-duty, rubber G-E Unicord, designed for use with washing machines, refrigerators and other large appliances.

For added sales appeal and long-life durability

SPECIFY G-E UNICORDS

For small or large appliances — lamps, vacuum cleaners, radios or TV sets; office equipment or power tools—the streamlined attractiveness and rugged strength of G-E Unicords will give added sales appeal to your product and contribute to trouble-free operation.

Unicords are designed to harmonize with the modern lines of present-day appliance styling. There are no loose ends of wire or insulation around the connection plug to annoy users of your product. The whole cord presents a single, smooth, compact design—to help gain customer preference for your appliance or electrical equipment.

For rugged strength G-E Unicords—lead-wires, cord and plug—are moulded in one piece. No separate parts to come loose and cause trouble. They are built to withstand strain and operational abuses that would quickly render other cords and plugs unfit for service.

There's a G-E Unicord for your appliance or electrical device—standard types are available from stock, custom designs produced to your specifications.

Lightweight, plastic Unicord with special television plug. These cords are also made in a wide range of styles for radios, fans, and lighting fixtures.

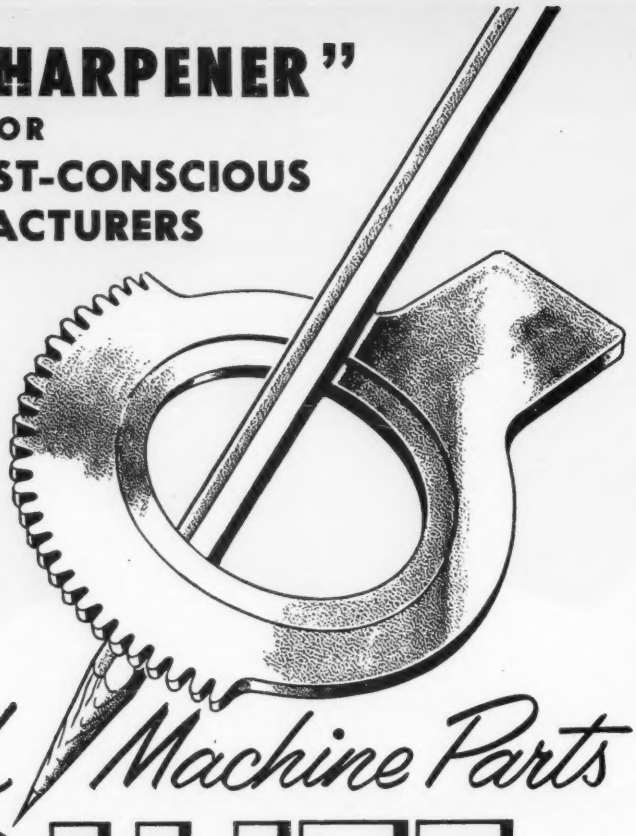
GE UNICORDS

403W-1154

Wire and Cable Department

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

"PENCIL SHARPENER"
FOR TODAY'S COST-CONSCIOUS MANUFACTURERS



Finished Machine Parts
MADE OF OILITE

At A Fraction of The Cost of Machining Solid Metals

If like most manufacturers, you've got to "sharpen your pencil" to compete successfully and profitably under present conditions, Oilite finished machine parts can help you!

When your parts are made by Oilite, you can reduce capital investments in terms of floor space and machine tools. *Most important,* unit cost is substantially lower because expensive tooling up — 5, 7, 10 or more machining operations and waste materials are all eliminated.

Oilite parts perform just as well — *often better,* because they can be made to close tolerances and if you wish, impregnated with oil for self-lubrication.

They are available in a broad range of ferrous and non-ferrous metals and alloys — assuring the strength, weight, porosity and other characteristics you require.

First deliveries can be expected long before normal tooling up could be accomplished!

The services of a skilled Oilite engineer are available to you without obligation. Write today!

INVESTIGATE OILITE SELF-LUBRICATING BRONZE BEARINGS, TOO — They're stronger, quiet, permit greatly decreased bearing clearances. Oil-cushion makes them excellent for shock and impact loads. Thousands of sizes for immediate shipment. Other Oilite Powdered Metal Products include cored and solid bars, permanent filters and special units.

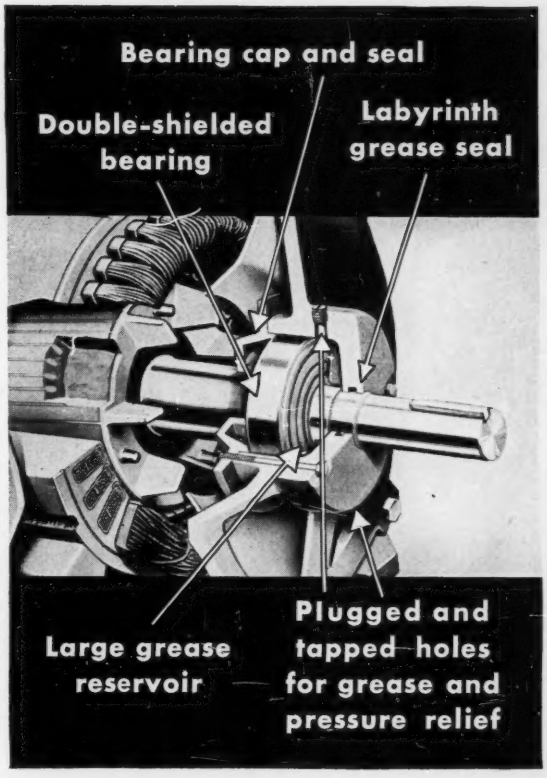
Products of Powder Metallurgy by
AMPLEX MANUFACTURING COMPANY
Division of Chrysler Corporation

A-B **ACME-BERTRAM**
MACHINE TOOLS LIMITED

Here Are Facts You Should Know About Electric Motor Bearings

AN ideal motor bearing would operate for indefinitely long periods under all types of conditions without requiring any attention whatever. However, in the opinion of our engineers, such a bearing and its attendant lubricant are not yet available on the commercial market. Consequently, bearings for many types of operations, particularly where overloading, extreme temperature ranges and chemical and dirt laden atmospheres are involved, require special lubricants or regular lubrication schedules.

Of course, bearings suitable for many kinds of operation under normal conditions can be built to require no attention for very long periods — usually several years. Allis-Chalmers can supply sealed bearings in all frame sizes through 505 on short delivery and without extra cost for applications of this type.


Bearing cap and seal
Double-shielded bearing
Labyrinth grease seal
Large grease reservoir
Plugged and tapped holes for grease and pressure relief

Which is the Best Design for *Your* Application?

We believe that the design used in standard Allis-Chalmers drip-proof, tefc and explosion-proof motors represents the best design for most industrial users.

The Allis-Chalmers standard design consists of a pre-lubricated, double-shielded bearing mounted in the end housing with a generous grease reservoir. Plugged and tapped holes are provided for grease and for pressure relief. Under normal operating conditions, this design will operate as long without attention as any other type of bearing in use today. But where difficult operating conditions make re-lubrication desirable, it can be done as part of the normal lubricating routine without dismantling the motor.

The large grease reservoir and shielded bearing design assure that grease lost from the bearing due to high operating temperatures or other causes will be replaced automatically.

For further information on bearing design and other features of Allis-Chalmers motors, call the CA-C Sales Office nearest you, or write Canadian Allis-Chalmers Ltd., St. Thomas, Ont.

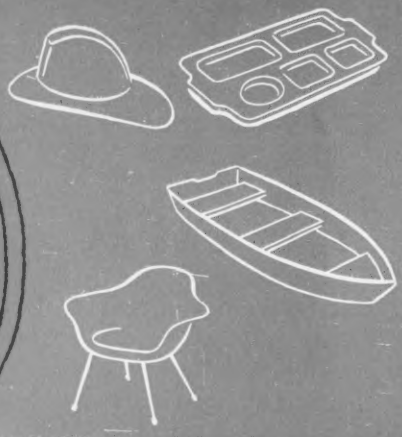
MADE IN CANADA

CANADIAN ALLIS-CHALMERS

54-CAE-8

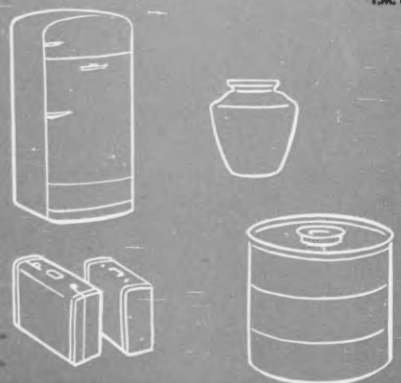
What's new in F.R.P.?

FIBERGLAS REINFORCED PLASTICS

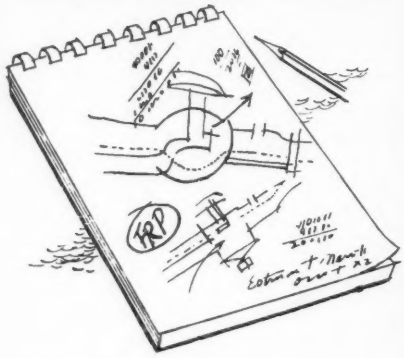


Many manufacturers are finding that they can cut costs and improve their product by the use of F.R.P. With a strength-weight ratio in excess of any other known material, these plastics make it possible to fabricate lightweight articles of amazing strength and durability. Perhaps F.R.P. is what *your* product needs to put it out front in sales and consumer acceptance.

*T.M. Reg'd.



THINK F.R.P. before you start



When you first tackle a new assignment . . . *that's* when Fiberglas Reinforced Plastics can really simplify the problems before you. In FRP you have a material that can be formed into practically any shape. It's tougher than steel, colourful, dent-proof and remarkably corrosion resistant. It won't rust or scale. With all these qualities at your command many of the biggest headaches in design simply disappear.

FIBERGLAS*

is a registered trade-mark which identifies in Canada products of

FIBERGLAS CANADA LIMITED

FIBERGLAS CANADA LIMITED

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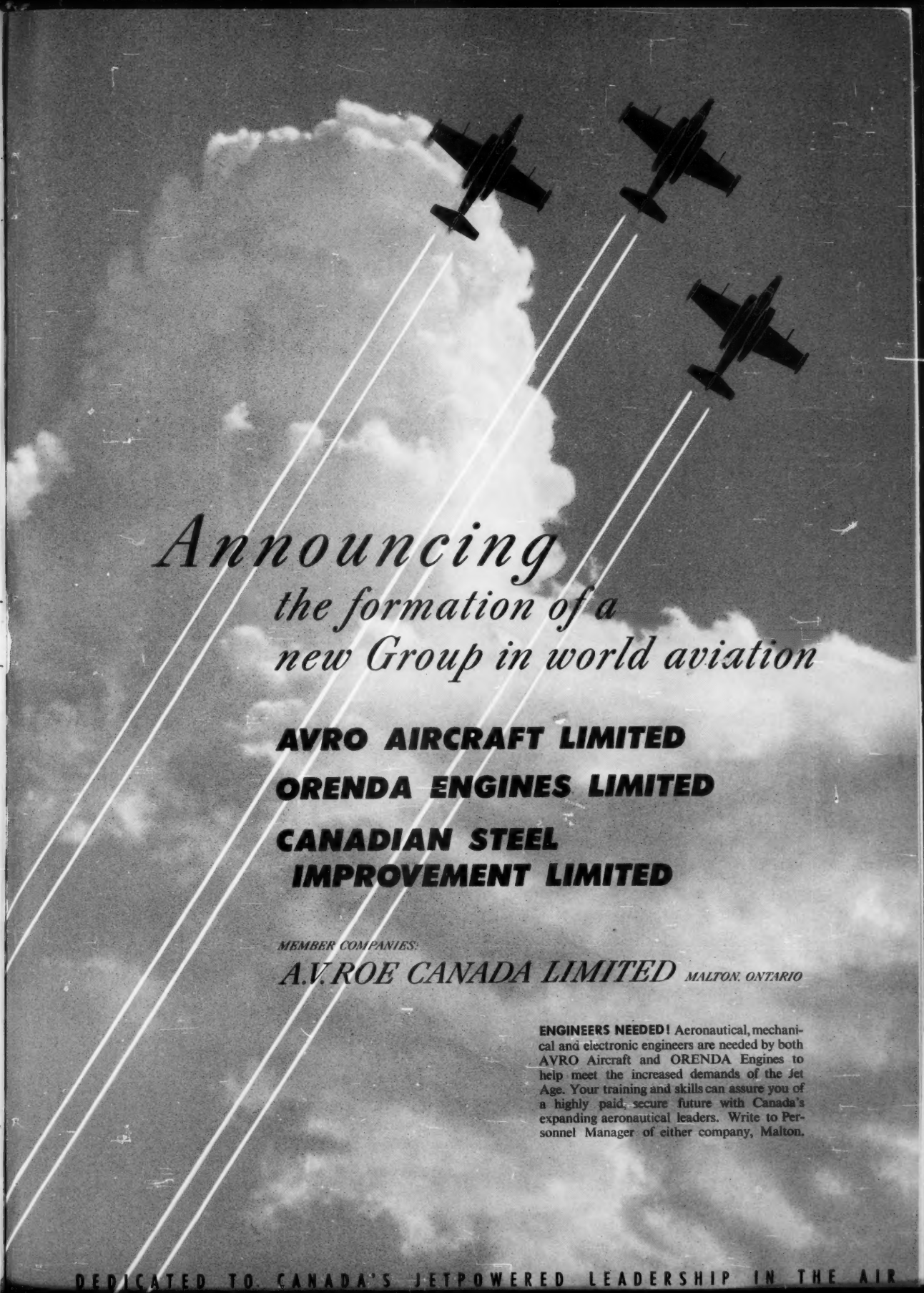
Announcing
the formation of a
new Group in world aviation
AVRO AIRCRAFT LIMITED
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ENGINEERS NEEDED! Aeronautical, mechanical and electronic engineers are needed by both AVRO Aircraft and ORENDA Engines to help meet the increased demands of the Jet Age. Your training and skills can assure you of a highly paid, secure future with Canada's expanding aeronautical leaders. Write to Personnel Manager of either company, Malton.
DEDICATED TO CANADA'S JETPOWERED LEADERSHIP IN THE AIR

Take off

FOR

AVRO AIRCRAFT

A world-famous name sharing a heritage of 46 years of flight takes off on its new career. With its own established record of design and production achievements reflected in the constant output of CF-100's for the R.C.A.F., AVRO Aircraft assumes an independent and experienced role in world aviation.

Already successfully test-flown for nine years, the new Company will direct the efforts of 10,000 experienced designers, engineers, technicians and skilled production workers. Assurance that AVRO Aircraft can meet the increasing demands of the Jet Age is confirmed by the proven development record of its extensive engineering staff, every member of which is constantly at work on aeronautical research and design for the future.

With management and policy unchanged, AVRO Aircraft continues to discharge its responsibility as one of the main industrial arms of the R.C.A.F. and through present and future projects reinforce and maintain Canada's air defence.

AVRO AIRCRAFT LIMITED
MALTON

DEDICATED TO CANADA'S JETPOWERED LEADERSHIP IN THE AIR

ORENDA . . . *a new power in the Jet Age!*

Orenda Engines begins its corporate life with an established record of engineering and production achievement, with management and policies unchanged and with the same goal . . . leadership in the field of aerial propulsion.

From Orenda's design, development and production departments came the first all-Canadian jet engine to power the CF-100 and F-86 Sabres V and VI. Since September, 1952, the company has delivered over 1,500 Orendas. Expanded research facilities are now under construction to deal with the increasingly complex power requirements of the future.

The 6,000 people in the Orenda family are dedicated to designing, manufacturing, maintaining and servicing modern jet engines and other forms of aero power and to the building of a sound aircraft industry for the defence and development of Canada.

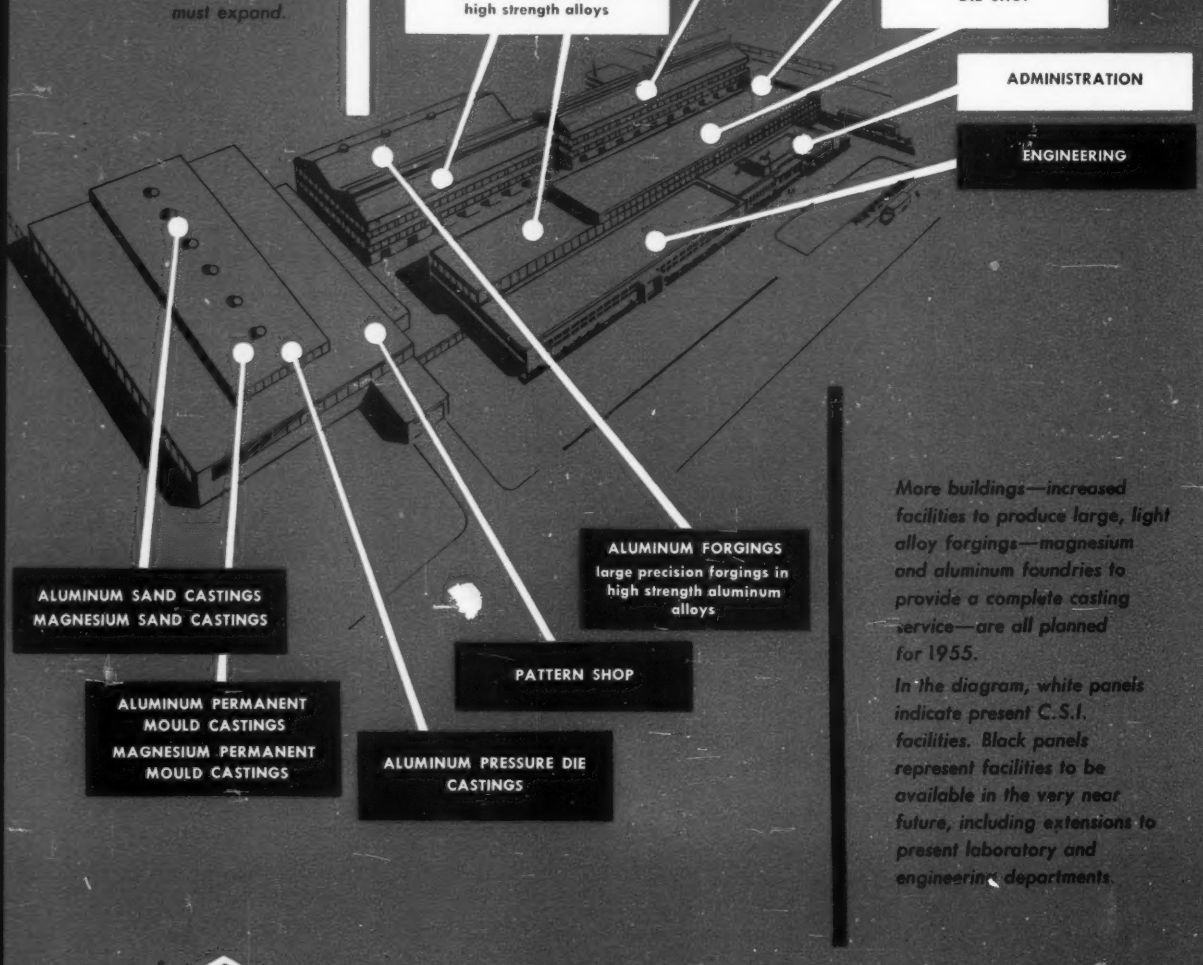
*ORENDA: Source of all power—*Iroquois*

ORENDA *ENGINES LIMITED*
MALTON

DEDICATED TO CANADA'S JETPOWERED LEADERSHIP IN THE AIR

Quality forgings and castings for a growing Canada

CANADIAN STEEL IMPROVEMENT LTD. offers a complete forging service to Canadian industry. They produce components of the highest standards in steel, high temperature alloys, aluminum, titanium and other non-ferrous alloys. To keep pace with Canada's rapid industrial growth, C.S.I. must expand.



More buildings—increased facilities to produce large, light alloy forgings—magnesium and aluminum foundries to provide a complete casting service—are all planned for 1955.

In the diagram, white panels indicate present C.S.I. facilities. Black panels represent facilities to be available in the very near future, including extensions to present laboratory and engineering departments.

CSI **CANADIAN STEEL IMPROVEMENT LIMITED**

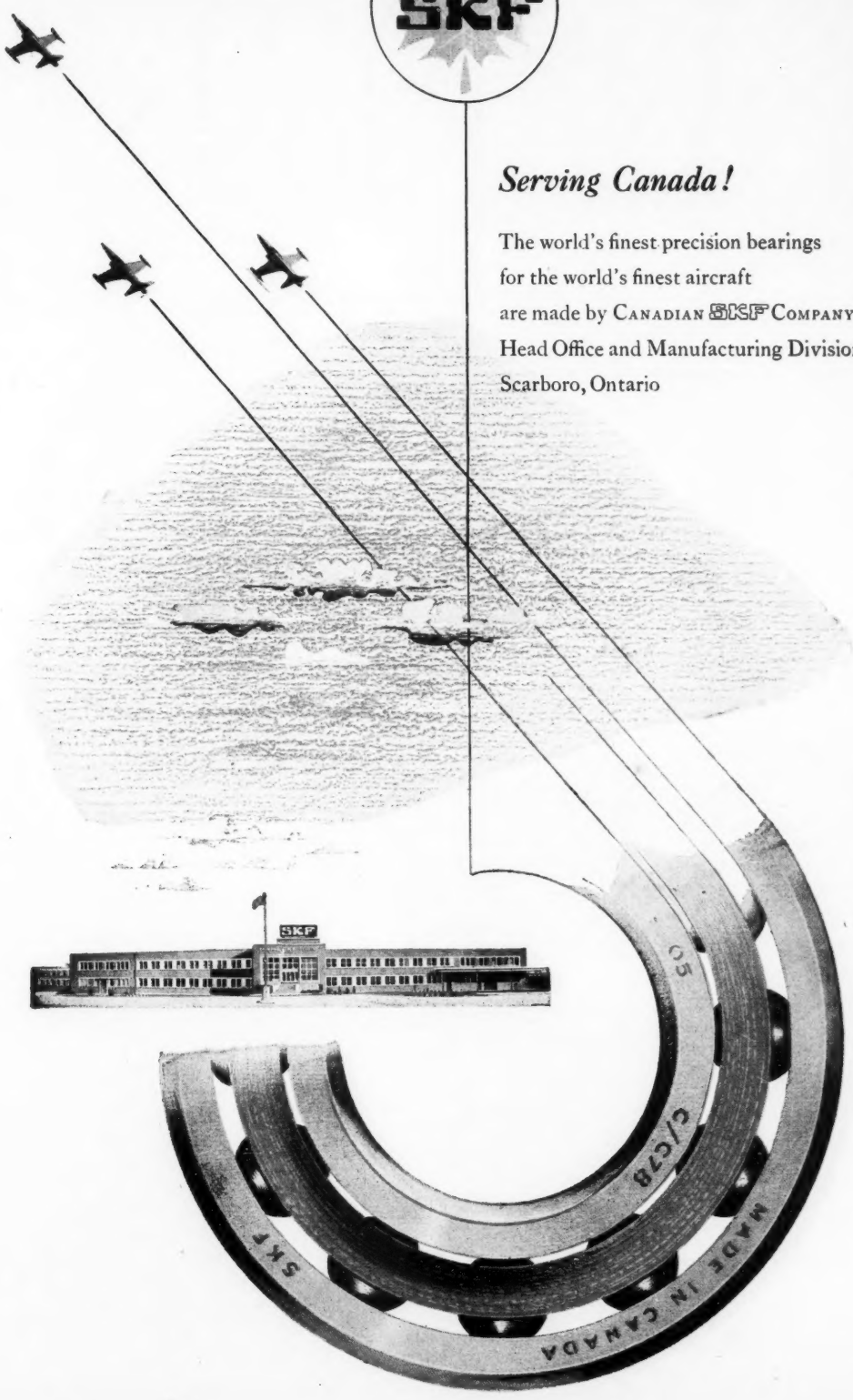
HORNER AND SECOND AVENUES, ETOBICOKE, ONTARIO.

MEMBER COMPANY; A. V. ROE CANADA LIMITED

SKF

Serving Canada!

The world's finest precision bearings
for the world's finest aircraft
are made by CANADIAN SKF COMPANY LIMITED
Head Office and Manufacturing Division
Scarboro, Ontario



STAINLESS STEEL
CASTINGS

Shawinigan Chemicals makes a wide range of stainless steel castings — large or small, simple or intricate. Regardless of size or type of stainless steel, Shawinigan will turn out the castings needed to handle YOUR heat or corrosion problem.

Our Technical Staff will assist you gladly.

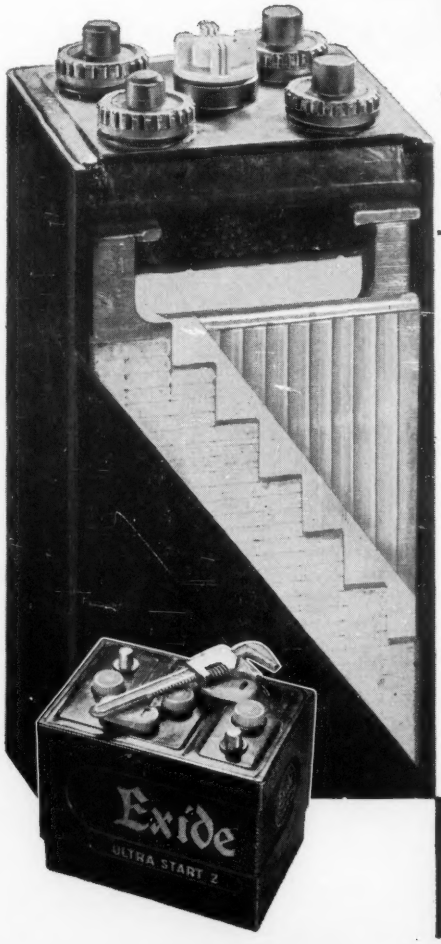
SHAWINIGAN CHEMICALS LIMITED
STAINLESS STEELS & ALLOYS DIVISION

HEAD OFFICE: SHAWINIGAN BUILDING, MONTREAL — — — PLANTS: SHAWINIGAN FALLS

Problems solved-with

polythene

Modern Industry uses polythene's many properties... to improve product efficiency and life... reduce cost and weight.



This battery now has 20% more capacity and life. Non-corroding polythene tubes and sealing bars reduce "sediment space", allow larger plates with greater capacity. Polythene terminal caps guard against accidental "shorting".

Flexible polythene spring liners used between car spring leaves are made by Ontario Steel Products Company Limited, reduce wear, noise and vibration. The polythene strips act as a dry lubricant—result: improved efficiency, problems solved.

Polythene is a tough, light, flexible material which has an unusual number of outstanding physical and chemical characteristics. It is moisture-proof, corrosion resistant, non-toxic and chemically inert. Polythene remains flexible and strong even at sub-zero temperatures and has excellent dielectric properties. It is used in industry for such widely divergent products as flexible pipe, packing rings, carboys, electrical insulation and many other items.

Consider polythene in relation to *your* problems—it may be the key to increased sales, reduced costs, simplified production. For further information or technical assistance, write Canadian Industries (1954) Limited, P.O. Box 10, Montreal.

C·I·L

plastics

SUPPLIERS OF PLASTIC RAW MATERIALS

3M COMPANY

ADHESIVES, COATINGS and SEALERS

The tools that solved some of the world's toughest design problems

ADHESIVES: One man completes the assembly of 1000 compressor housings every 8-hour shift since a special "3M" Adhesive replaced a weld-and-screw method.

COATINGS: "3M" Coating #EC-244. The rubber-based coating on these underground tanks means years of complete protection against corrosion and rust.

SEALERS: The perfection of a "3M" Sealer made possible the design of integral fuel tanks . . . actually using the aircraft wings to contain gasoline.

1,000 different types—each developed for a specific requirement

Before you start work on any design project, consider the advantages of "3M" Adhesives, Coatings, Sealers. Whether your problem is *joining* or *sealing* glass, metal, plastics, leather, textiles, rubber or wood—or *protecting* surfaces against abrasion or chemical or physical corrosion—there's a "3M" product for the job. These special formulations have been the product or supplementary product used by design engineers for hundreds of fastening, sealing and protecting problems. Very often one or more of these 1000 special "3M" formulations even eliminate costly drilling and tapping operations. Consult your "3M" representative for complete information and write us for your copy of "SWEETS FILE" INSERT on "3M" ADHESIVES, COATINGS, SEALERS.

3M COMPANY

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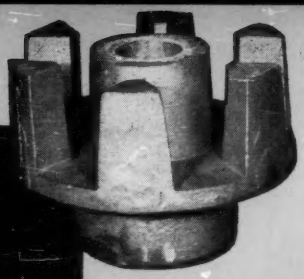
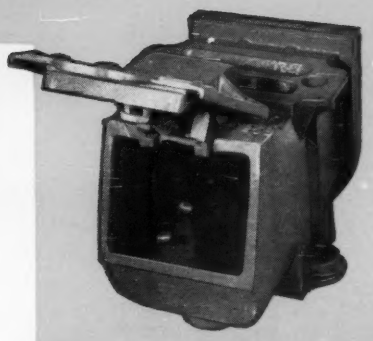
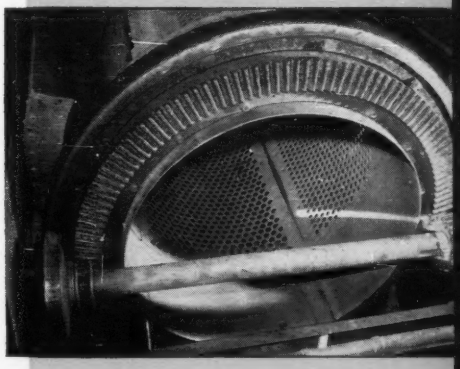
RE-DESIGN FOR Ductile Iron







DUCTILE IRON provides mechanical properties approaching those of cast steel. In addition, it combines the machinability and wear-resistance as well as the fluidity and castability of cast iron.

CHARACTERISTICS OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness.
2. It can provide a chilled, carbidic, abrasion-resistant surface supported by a tough ductile core.
3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.
4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.
5. It can be satisfactorily welded.
6. It resists oxidation and growth to an extent never before available in normal gray iron castings.
7. It can be cast in intricate shapes not normally feasible for cast steel.
8. It is generally more corrosion resistant than cast steel.

INCO *proven* SERVICE

Working closely with foundries, metallurgists and design and production engineers has developed a fund of valuable data which is yours for the asking. Inco's technical staff is ready at all times to assist you.

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED
25 KING STREET WEST, TORONTO, ONTARIO

EMBLEM OF INCO SERVICE TRADE MARK

The International Nickel Company of Canada, Limited,
25 King Street West, Toronto, Ont.

Please send me a list of available publications on DUCTILE IRON.

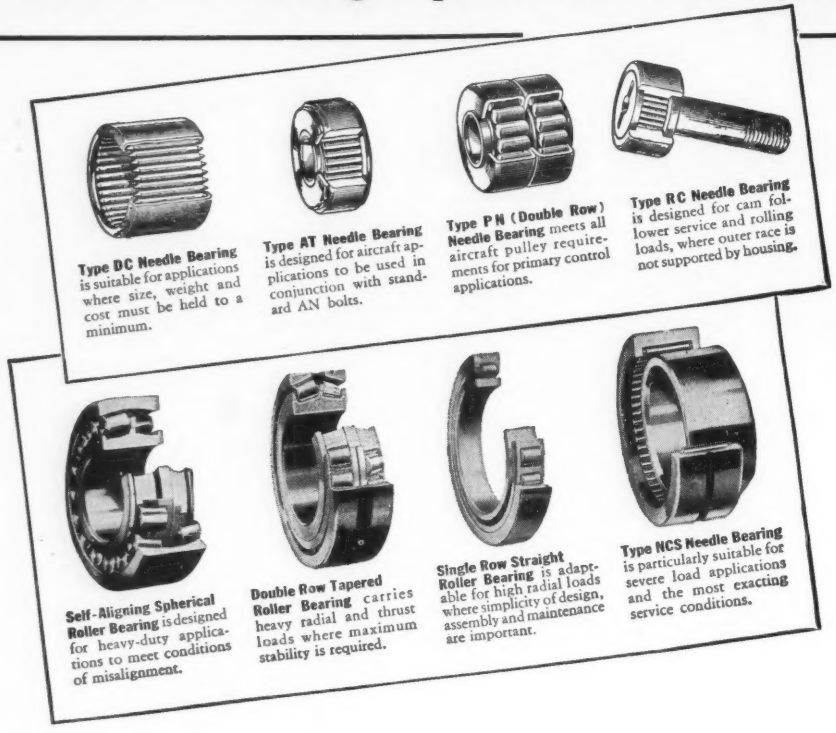
NAME .....

COMPANY .....

ADDRESS .....

6-DI

One of these Torrington Bearings may solve a design problem for you...



Type DC Needle Bearing is suitable for applications where size, weight and cost must be held to a minimum.

Type AT Needle Bearing is designed for aircraft applications to be used in conjunction with standard AN bolts.

Type PN (Double Row) Needle Bearing meets all aircraft pulley requirements for primary control applications.

Type RC Needle Bearing is designed for cam follower service and rolling loads, where outer race is not supported by housing.

Self-Aligning Spherical Roller Bearing is designed for heavy-duty applications to meet conditions of misalignment.

Double Row Tapered Roller Bearing carries heavy radial and thrust loads where maximum stability is required.

Single Row Straight Roller Bearing is adaptable for high radial loads where simplicity of design, assembly and maintenance are important.

Type NCS Needle Bearing is particularly suitable for severe load applications and the most exacting service conditions.

It may not have occurred to you that there are so many *different* types of Torrington Bearings—or that the completeness of the line of these modern, anti-friction bearings makes them adaptable to many design requirements.

Pictured above are eight different types—and there are others, all different in design, to assure you a wide choice to meet any specific requirement. Each is engineered for a particular task—or combination of design requirements. Individually each offers the same characteristic advantages of unit design, anti-friction operation, high capacity, efficient lubrication, simple installation and maintenance.

The result is that in almost any application where Torrington Bearings are employed the design problem is simplified; operating efficiency and service life are increased; manufacturing costs are reduced; and sales features are added.

Investigate for yourself how the advantages of Torrington's *complete* line of anti-friction bearings can be of assistance in your product planning. Full information is available on request, and our engineering staff is ready to help you with any design requirement.

THE TORRINGTON COMPANY, LIMITED
925 MILLWOOD ROAD • LEASIDE ONT.

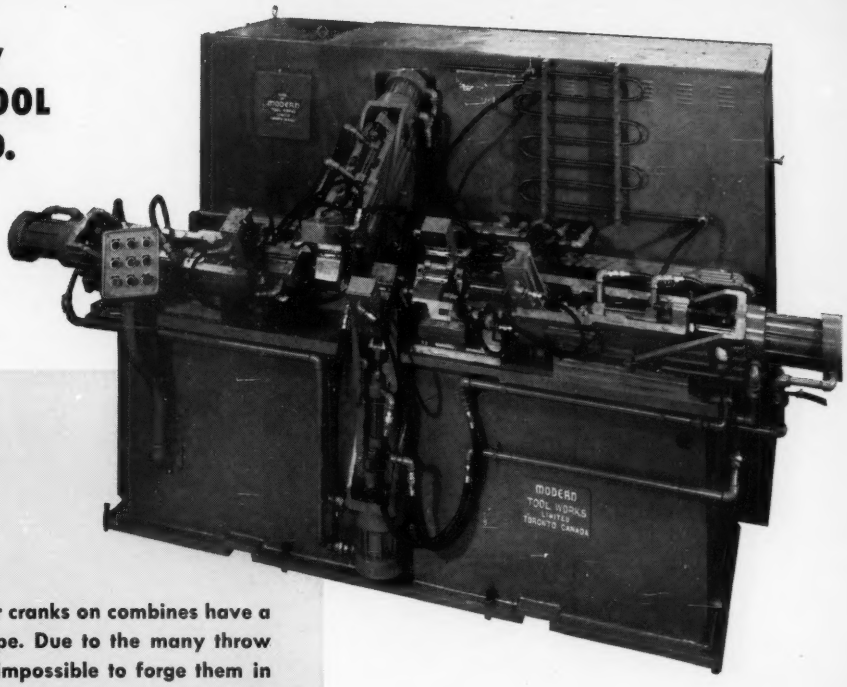
TORRINGTON BEARINGS

NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL

Massey-Harris

CUTS MANUFACTURING TIME BY 94%

with machine constructed by
MODERN TOOL WORKS LTD.



Straw-walker cranks on combines have a peculiar shape. Due to the many throw angles it is impossible to forge them in one piece. Therefore it was necessary for Massey-Harris to forge two separate pieces, butt weld them together and then have them machined.

Result: A crank that caused excessive vibration of the combine and required 75 minutes to manufacture. Massey-Harris took their problem to the Engineers at Modern Tool Works.

Result: The above machine which makes a balanced crankshaft, no machining required, in one piece in only 4½ minutes. A TIME SAVING OF 94%.

Bring *your* manufacturing problems to Modern Tool Works. There may be one or a hundred and one manufacturing processes in your plant which can be simplified and produced on an automatic or semi-automatic special machine. Our engineers specialize in cutting production time and unit costs. We would be pleased to work with you.
No obligation of course.

IF YOU WANT TO CUT OVERHEAD—
PRODUCE A BETTER PRODUCT FOR LESS MONEY...

GO MODERN **MODERN TOOL WORKS LIMITED**

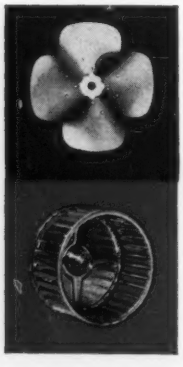
69 Montcalm Ave., Toronto

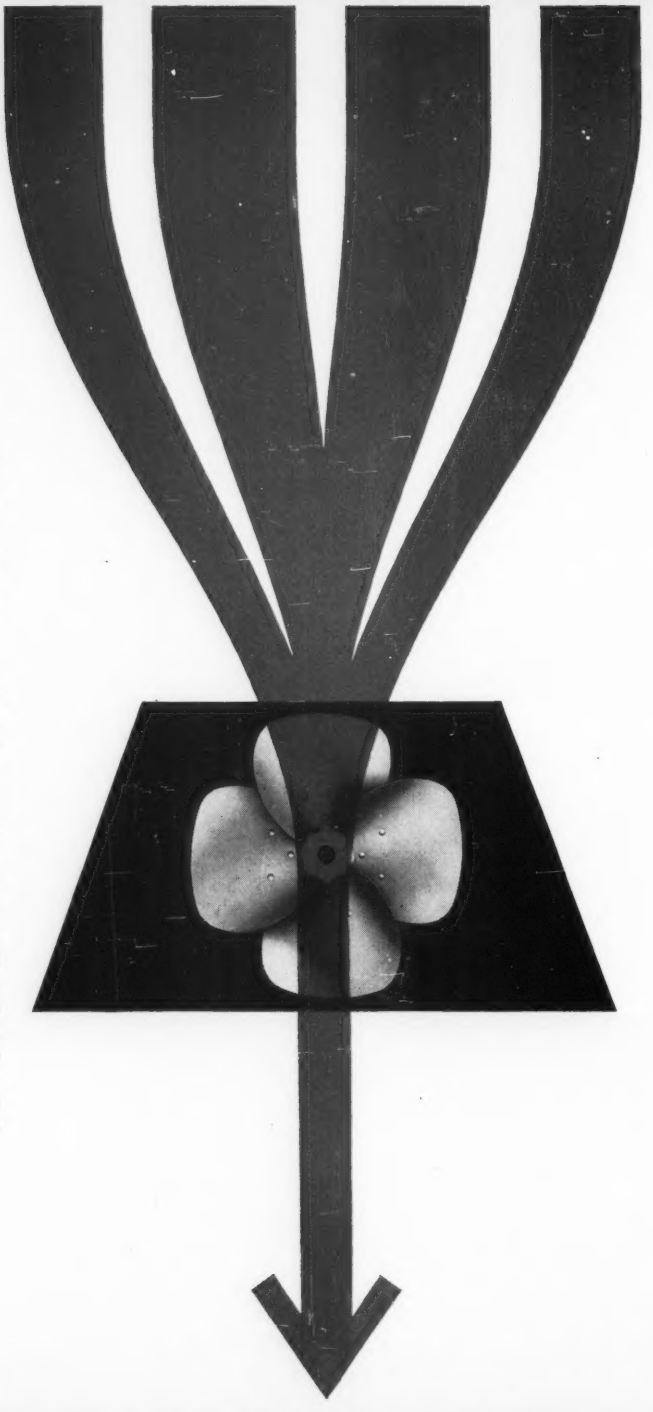
Maximum Air Delivery in Pressure Applications

...that's what you get with the Torrington "P Series" fan blade

Designed for a wide variety of pressure applications, the "P Series" fan blades turns in a top performance in many leading makes and models of modern air-moving equipment. Large blade area in relation to diameter gives maximum air delivery. Available in 10"–11"–12"–13"–14"–16"–18" diameters.

The "P Series" fan blade represents only a small portion of the unusually broad variety of air-impellers which Torrington is currently equipped to produce for heating, ventilating and air-conditioning equipment. This product range, plus Torrington's great capacity, can provide... quickly and at low cost... the fan blade or blower wheel that's best suited to your air-moving requirements. Torrington also maintains a complete research testing service for assistance on any design problem relating to air flow, sound and vibration. This service is always available to you and can be of particular value in the early stages of product design and development. No one has more experience in the design and production of air-impellers than Torrington. Nowhere else can your dollar buy so much in terms of product quality and customer service.





THE
TORRINGTON
MANUFACTURING COMPANY
OF CANADA LIMITED
OAKVILLE ONTARIO
TORRINGTON, CONN. VAN NUYS, CALIF.

VIP's

Important people who are in the news

ALTHOUGH IT IS the world's oldest gear drive, standards have never come to the worm and wormgear. Canadian engineer **Frank G. East,** vice-president and general manager of the strong Hamilton Gear and Machine Tool Co., decided it was more than time they did. "Right now," he said, "you can use as many pitch diameters as you can measure." In 1953, he gave a paper to an ASME meeting explaining why and how this should be changed. Pitch diameters, he urged, should be multiples of ½ in. ("teeth") pitches.

The ASME was impressed. His paper won second machine tool award ($75 and a citation) for 1954 and now the ASA has made him chairman of a subcommittee charged with finding some way of putting his ideas to work.

What is CSA's interest in all this? "I'm talking off the top of my head," says East, "but they might take it up."

• • •

THE FIRST HONORARY fellowship to go abroad from the newish Canadian Aeronautical Institute, has been given to **G. H. Dowty,** president of Dowty Equipment of Canada Limited. Dowty is English, a past president of the Royal Aeronautical Society and chairman of a group of British companies.

Dowty Equipment of Canada Ltd., has been in business for 15 years. During this time, President Dowty has come to Canada regularly at about 18-month intervals. When efforts to form the CAI were at a crucial stage (in 1952), Dowty was president of the RAeS; his influence did much to win cash support from the powerful British society which linked with three other "parent" bodies to give Canada's own institute a firm future.

By giving away one of the rare honorary fellowships, the CAI has said thank you to a good friend.

• • •

WRAPPED IN A SHROUD of security, three U. S. International Business Machine Corporation men came recently to London (Ontario) for talks. There they met **J. R. Bach** and **R. Wilton,** directors of Welwyn Canada Ltd., to review a contract which has existed between the companies for two years. The result: the contract will continue.

The Canadian company supplies high stability carbon resistors to IBM who, cramped by security worries, have forbidden the release of information beyond a brief, well-screened handout.

Explained a Welwyn official: "I would like to talk—it's not bullheadedness. But I can't do it."

An outside source gave an opinion: "IBM gets a better product for a better price from Welwyn than at home."

The transistors are believed to be used in the military computing field and to be the subject of a big contract.

• • •

Dominion Engineering's Tucker

DOMINION ENGINEERING COMPANY lays claim to being Canada's principal maker of diesel engines.

From its large diesel division, two new appointments have been made known. Manitoba-born **E. C. Tucker** has become division manager. Still only 33, Tucker headed east to Montreal as a graduate from Saskatchewan University in 1945. His climb to responsibilities was quick. In 1948, he was made head of sales and service for the division then, only four years later, went on up to assistant manager.

The division also has a new chief engineer. Englishman **R. E. Freemantle** came to Canada in 1939. He spent some of the war years building high-speed motorboats for the services, joined Dominion Engineering in 1946 as assistant chief engineer of the diesel division. He was later put in full charge of engineering now has his position confirmed.

• • •

AT LEAST ONCE every two years, the Engineering Institute of Canada awards a medal to a member for "outstanding services." When making the award the council is required to "take into consideration the life, activities and standing in the community and profession of the late Sir John Kennedy."

The winner of the Sir John Kennedy medal for 1954 has now been named as 66-year-old **John Bertram Stirling** MEIC, president of EGM Cape and Co., of Montreal.

Although Ontario-born, Dr. Stirling spent his first engineering years on prairie projects. In 1915 he joined his present company, became a partner in 1928, vice-president in 1940 and president in 1950. He has been prominent in Institute affairs, was vice-president in 1951.

How does his career compare with the late Sir John Kennedy's? The Institute was momentarily nonplussed when asked. "We'll have to dig through a lot of material," explained a spokesman who obligingly agreed to do so.

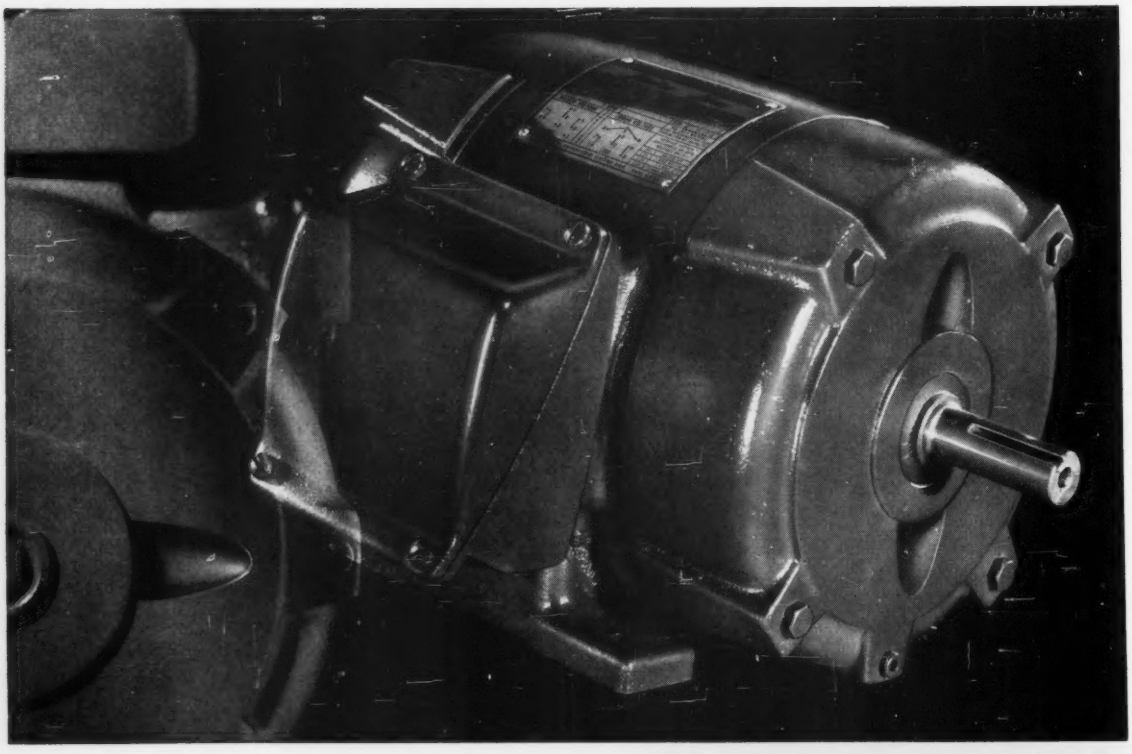
Sir John was born in 1838 to a Spenserville (Ontario) family but went to Quebec's McGill University. He became chief engineer of the Great Western Railway, then built Montreal's famous harbor. In 1892 he was elected president of the Canadian Society of Civil Engineers— the forerunner of today's Institute. Throughout his life he was known as a man of large abilities and honesty.

A careful look at Dr. Stirling's record shows that it is little less distinguished.

J. R. Bach and R. Wilton (both left) keep silent for safety

The Motor of the Year

Westinghouse Life-Line A



There's always a leader! In motors it's Life-Line "A" by Westinghouse, the company that developed the first induction motor.

The greatest protection, the best insulation, the finest precision manufacture ever offered in a motor are now ready to give you the most outstanding motor performance you ever had. Ask your Westinghouse representative for all the facts or write

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The BEST MOTOR ever designed by any manufacturer

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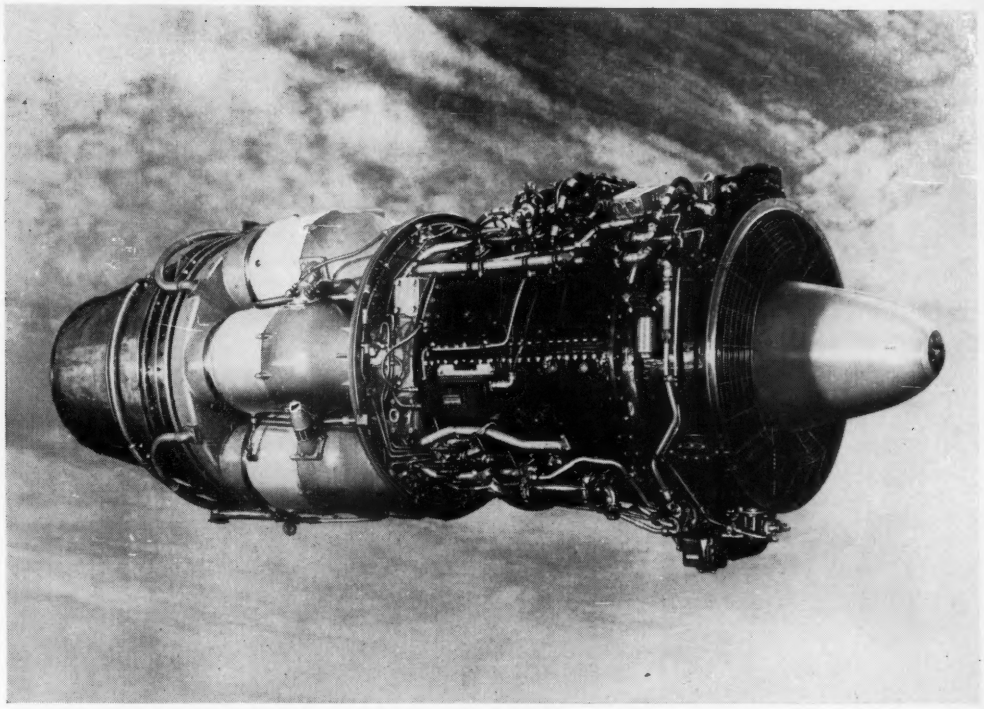


Canada's Orenda. All air-passage or rotating parts inside, it has to carry pipes and services outside.

Could Canada's Jet Engine Be Simpler than This?

Jet design never ends with production. There is always a change to make, seldom time to make it easily. What does this mean? Complex engines, says Orenda's chief designer

BY B. A. AVERY
Chief Design Engineer, Orenda Engines Ltd.

THE TURBO-JET ENGINE began as quite a simple piece of equipment. But through the years (eight for Canada's Orenda) it grew more complex. Why?

Partly, this is because requirements have got much more stringent. More power from the same size and weight of engine has been demanded and flying conditions have got steadily tougher.

But there is another reason for today's turbo-jet complexity; and this is the direct charge of designers.

Aircraft engine design, like the design of all machinery, comes from the study of function, manufacturing techniques, material properties, performance figures—and so on. Yet, there is a root difference between the design of aircraft components and components in other industries; because in the aircraft industry despite the need to keep design safety factors (and so weight) low—reliability has to be guaranteed under very hard working conditions.

Severe stresses and temperatures are routine. This means that tight control of materials and processes must

CONTINUED ON NEXT 4 PAGES

be kept. It means very careful study of proprietary parts and close liaison with their designers. It means, in a sentence, that all units going into prototype engines must be the best.

So a designer's knowledge is never complete. There are always gaps. It is those gaps that drive him toward the design of engines more complex than they need be for the job they have to do.

The designer must keep himself extremely well informed; he must make many sketches and layouts in the huge struggle for simplicity with performance; and he must discuss his proposals throughout with specialist stress engineers, materials engineers, planners and tool designers. Only this way is he likely to arrive at good functional design.

And a good functional design is one which is easily built and serviced, which has the fewest possible parts and so the lightest weight and the smallest appetite for its operators' dollars during a long, useful lifetime.

Apart from all this, the aero-engine designer must remember that some of his many assumptions may be wrong. He must remember that his engine will not be frozen for production but will be modified steadily for better performance. So he must try to build an engine which will absorb changes without too much difficulty.

History has shown that engine designs just do not get simpler or lighter during the development period.* Instead, they grow more complex, since, in this business, time is always short and a fix-it-but-don't-change-it technique is too often used.

The design period for a prototype is quite short. Of the total period of six to seven years that a repeat pattern is followed in the development and production-proving of a turbo-jet, only about 15 months can pass between drawing the first line on paper and running the first experimental engine.

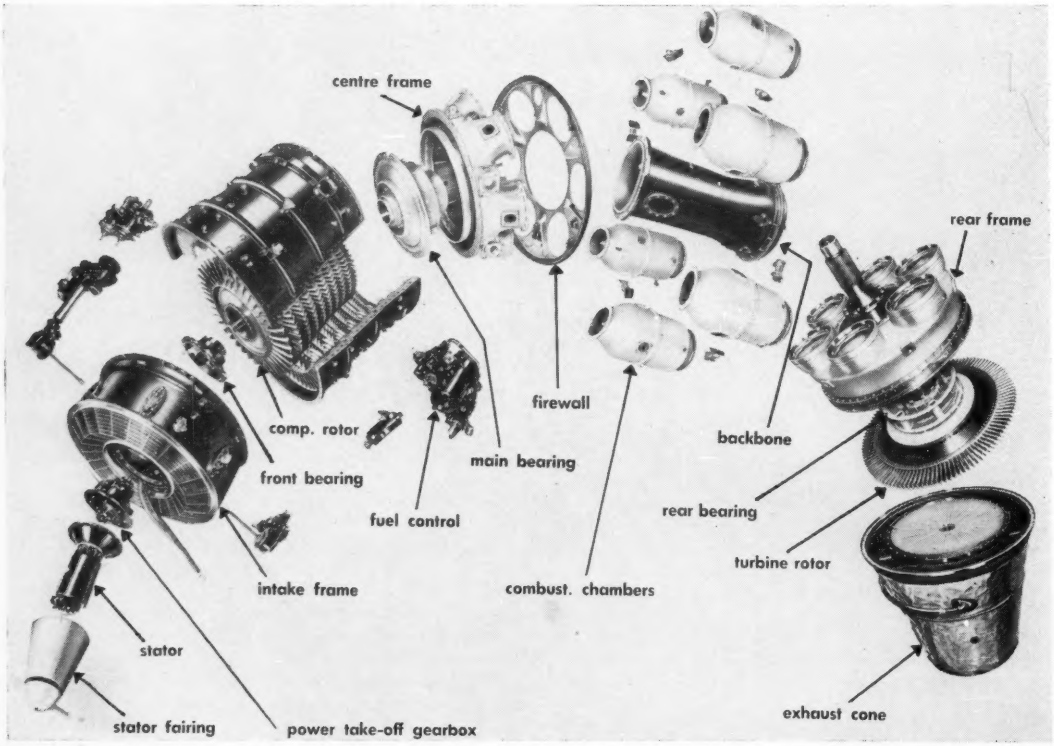
Of course, an engine is not completely designed during this short time. In the interim between design periods, designers are combining any needed redesign work with a study of progress in materials, methods, servicing experience—and so on; and whatever is learned from all this will affect their design thinking. Then, designers are also gleaning what news they can of other power plants in search for better ideas than their own.

In other words, the design staff is planning every day how to design the next engine, or modify the present one.

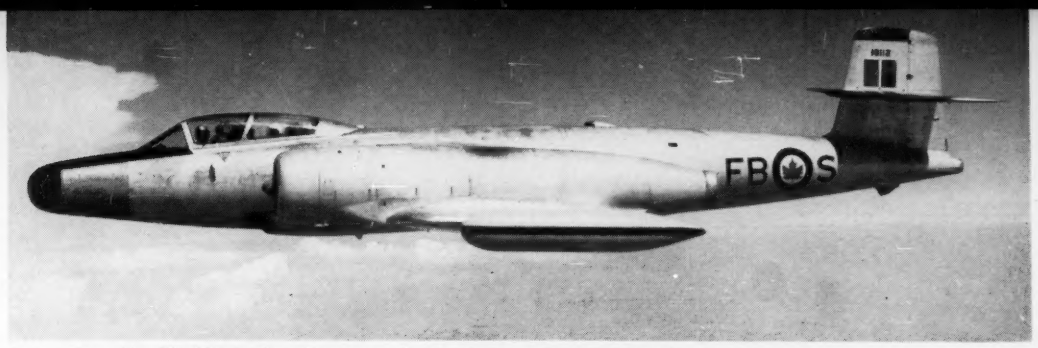
The usual result is that long before an engine reaches production, several improvements have been worked

*Complexity does not grow on aero-engines alone. As technology and gadgetry race forward, machine designers everywhere find it more and more difficult to be simple. Fortune magazine describes a struggle by the American navy to build a small, simple, (K class) submarine for mass production. "Inexorably," it reports, "the submarine took on weight." It became so "densely packed" with equipment (including . . . an ice-cream freezer) that it [now] has room for only four torpedoes . . ." The crew of 10 turned into 45, the cost rose to $10 million. And somewhere, simplicity got lost.

Every day they are planning how to design the next engine



1 *The Orenda is simpler than it looks. This exploded shot strips it of pipework, but shows all the main parts.*



Avro Aircraft's CF-100 is Orenda powered. It gives steady service with Canadian all-weather fighter squadrons.

The U. S. designed Sabre. When adapted to Orenda power, won a NATO listing as world's best operational fighter.

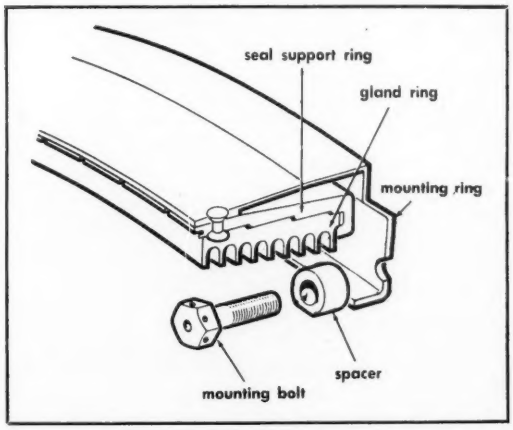
out. Once the production program has been reached it is sometimes difficult to include them. But when they have been well proved and type tested and if the customer approves, great efforts are made to build in the changes. And when it simply cannot be done—when excellent design changes just cannot be fitted into the production program—they are filed for future use.

The Orenda was designed quite conservatively for its time. This had to be, because the future of Canadian-designed aero-engines depended on how well it ran first time.

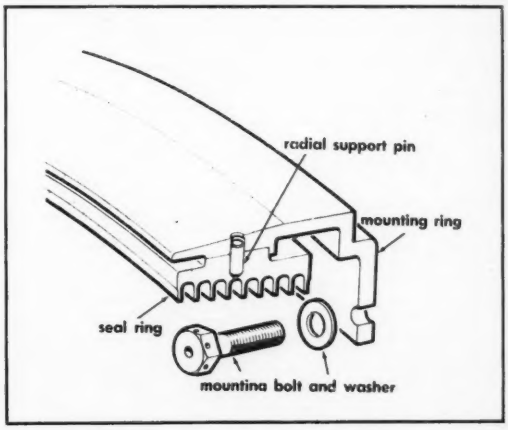
Nonetheless, the Orenda was designed to at least equal the performance of the largest engines then on the drawing boards anywhere, and to stand up to full fighting conditions up to the speed of sound at sea level. Wherever it could be done, proved methods of construction were used since our own experience and research facilities were a little meagre. Features like an annular combustion chamber which might have led to performance improvements but which needed facilities we did not have, had to be laid aside. Even so, the Orenda combustion chambers are the largest and most efficient of all similar engines of its generation. And the compressor gives the highest pressure ratio for the number of stages used.

The exploded photograph (PICTURE 1) shows all the chief parts that go into the Orenda 10. Basically, the engine is made up of a 10-stage axial flow compressor, six combustion chambers, a single-stage axial flow turbine and an exhaust cone.

The forward frame of the compressor supports the front end of the compressor rotor, houses the power



2 *This labyrinth seal gave trouble. Made up of three parts it had a thin unstable mounting ring. So they . . .*



3 *. . . reduced the parts to two, designed a new mounting ring. This seal is not only better — it is simpler.*

continued

take-off gearbox for driving accessories, supports the compressor inlet vanes and, in the case of the Orenda 10, a starter generator.

The mid frame (which connects to the front frame by the compressor stator assembly) houses the main rotor thrust bearing, incorporates the main engine support trunnions—and acts as the compressor diffuser and transition from the annular compressor or outlet to the six combustion chambers.

The rear frame which is linked to the mid-frame by a backbone structure, carries the turbine rotor. It also acts as the transition from the six chambers to the annular turbine passage and supports the turbine nozzles.

Big trouble can come from small parts. The labyrinth seal (it shows in PICTURE 1) on the compressor, for instance, has to give the lowest loss of delivery air and reduce thrust loads on the main bearings by lowering the pressure behind the rotor. The disc rim rotates inside the seal with a radial clearance of about .015 in. But there was a thermal expansion differential to allow for. This led, at first, to an assembly of three main parts (PICTURE 2). The steel mounting ring was slotted at the flange close to the aluminum structure to allow for the expansion snag—but it was thin, difficult to machine and quite unstable. A ring riveted to it was also of steel and the idea was that the average deflection of this ring and the aluminum gland ring fitted inside it, would be very nearly the same as the sum of the thermal and centrifugal expansions of the disc. The theory was quite sound; but the aluminum yielded in compression when it was hot and became loose on shut-down. Then on later runs, rubbing would start, wear would follow and soon there would be too much air leakage. So, the seal was redesigned.

The new one (PICTURE 3) is made up of a rigid, easily machined, aluminum alloy mounting ring—which expands directly with the aluminum (or magnesium) mid-frames. Fastened to it by radial pins is a mild steel gland ring which can only expand thermally—and so rather less than the disc. This gives the minimum clearance while the engine is running but still gives quite a good "build" clearance and so less chance of assembly damage.

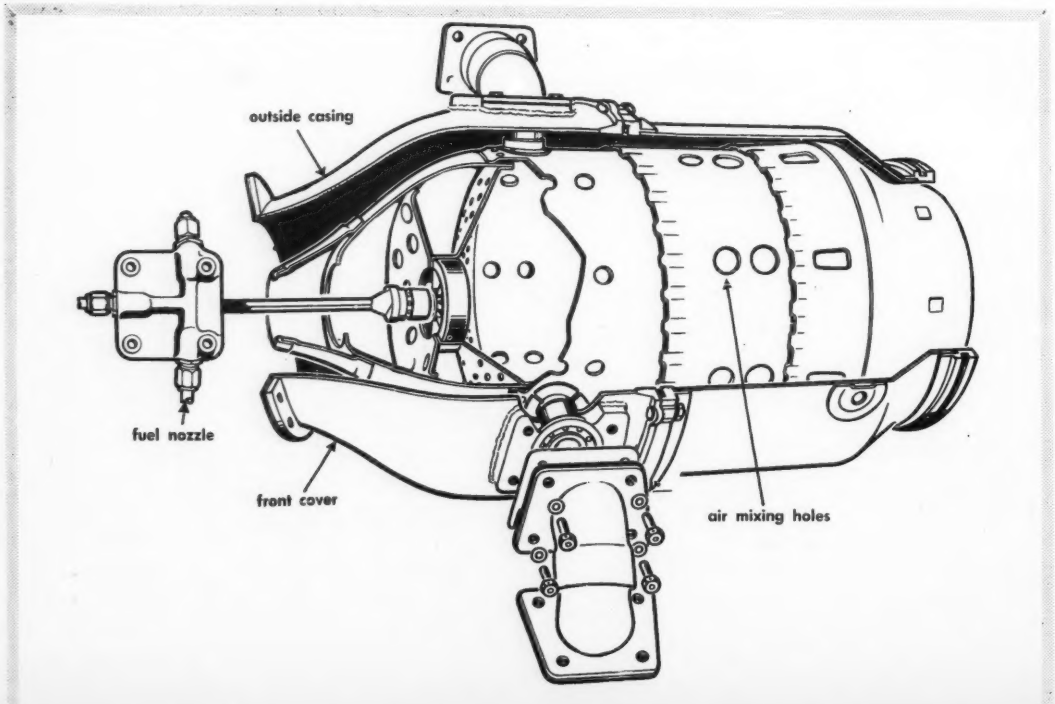
This may sound like a great deal of effort to improve a small part—but remember that the chief job of a turbo-jet engine is to pump air. Air leakage is serious and worth careful design. A one per cent loss of this compressor air may mean a two per cent efficiency loss to the whole engine.

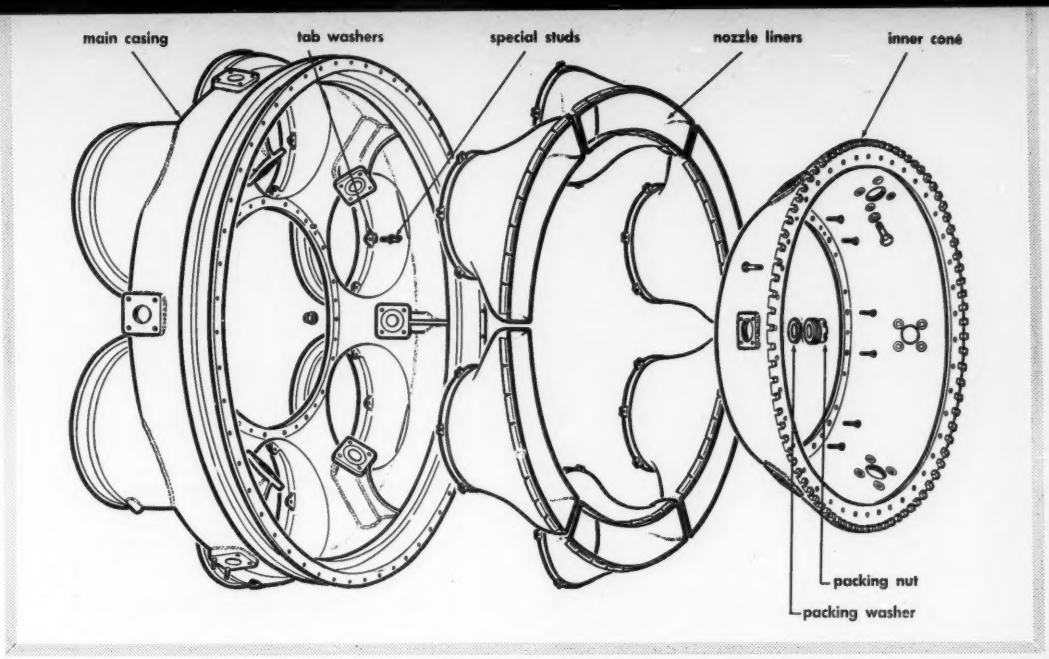
And there is more than this to it. Axial thrust has a big effect on the life of the main rotor bearing. This is the net sum of very large gas loads balanced against each other. So, the pressure behind the compressor rotor (acting on the large area of the last disc) will add to the bearing thrust and subtract from the rotor bearing's life unless it is carefully controlled. The bearing thrust load varies with conditions from about 500 to 12,000 lb. An increase in the seal clearance of only 0.10 in. might push up the load by as much as 2,000 lb. So this small part has a double importance. Its redesign improved engine efficiency and added to bearing life.

Each combustion chamber (PICTURE 4) was originally made up of a nickel alloy inner liner (or flame tube), a cast aluminum alloy front casing and an aluminized mild steel rear casing. Hand polishing was used on the edges of parts, including the holes, to prevent cracks; but this was replaced by simple deburring when its was found that it did not lead to worse cracking.

These liners have to take very tough conditions. Much has been done to give them longer life and make

4 *Combustion chambers have to stand up to "very tough conditions." But welded mild steel proved good enough.*





5 *A "terrific amount" of raw material was once wasted on the nozzle box. Sheet steel for the casings stopped it.*

'Designers must see that complexity is the easy way . . .'

them simpler to produce so that their cost per hour of life can be cut down. The forward casing is now fabricated in mild steel to match the rear casing—since building up is quite good enough for this part. Welds can be reworked if they are not pressure tight whereas the aluminum casings had to be rejected. Then the machined pilot diameters once used at the centre joint have been done away with and the bolts connecting the two sections together are relied on to give good alignment.

Even the finish has been revamped. The sprayed aluminum coating on the mild steel rear casing has given way to a silicone paint finish which fights corrosion better and is cheaper to use. And so it goes on.

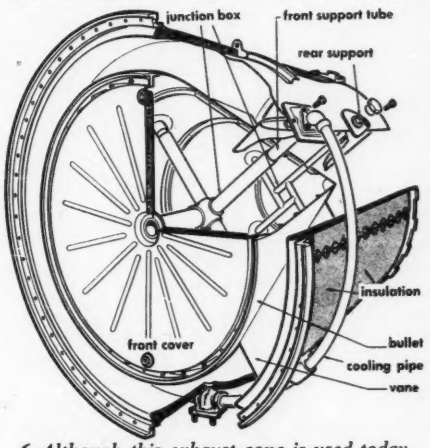
The compressor stator casing consists of two magnesium castings bolted together at horizontal flanges. The original design had aluminum half-rings supporting the aluminum alloy blades in broached slots clamped against the inside of the castings by aluminum alloy rings and steel bolts.

Fear of fire was behind this method. It seemed a risk to have the rotor blades rubbing directly on the magnesium castings. But then, experience showed that the fire hazard was unreal and the method was changed.

Now, the same aluminum blade rings are mounted directly in T-slots machined in the inner walls of the castings. Three similarly mounted rings form the air take-off manifolds and simple aluminum buttons put in at the horizontal flanges stop the rings from rotating.

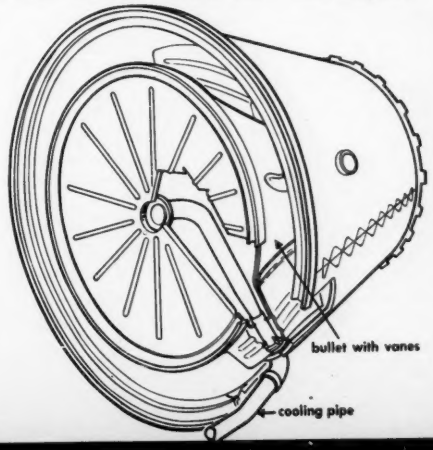
Doing away with spacer rings and bolts (and so reducing tolerance build-up) allows the inner gas profile to be machined at the same time as the slots are machined in the casings. While using the older method, both spot-facing and end milling were needed to get wrench clearance at the casing flanges. But in the newer design, the outer diameters of the casings close to the end flanges were decreased without decreasing the metal thicknesses—and so simple automatic end milling be-

(Continued on page 66)

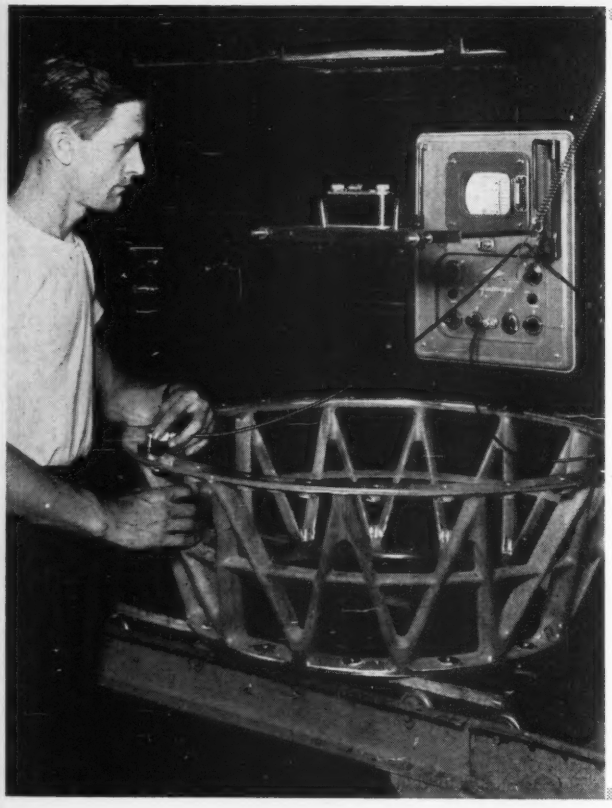


6 *Although this exhaust cone is used today, it is complex and costly. A better one . . .*

7 *. . . will soon be put into new engines. This one is cheaper, trouble-free — and simpler.*



Let a Pulse Search Out the Defect



BY M. J. MARKO
Non-Destructive Testing Corporation

High-frequency sound pulses will probe your product for defects. This is the modern way to find below-the-surface trouble. You can throw out the factor of ignorance, pare the factor of safety — then make a better product cheaper

An on-the-line check. This aero engine frame is having a routine "reflectogauge" type test.

NEARLY EVERY wartime sailor has heard the thin high-pitch "ping" of an "asdic" pulse — and hoped not to hear it bounce back from a submarine's flank. Now industry has started using much the same idea to find flaws in manufactured products and it is the engineer's turn to worry about pulses that should not come back, but do.

This is ultrasonics — and in theory the whole operation is simple. In practice, you are likely to be flummoxed by your readings unless you have a broad knowledge of the physics involved.

The advantages of the method are obvious. You can inspect the insides of your product without taking (or breaking) it apart. Instead, you shoot pulses through or across the material, then watch a radar-type screen for blips. A hidden defect will reflect pulses, cause an extra blip on the screen and so lead you to a trouble spot.

In the basic industries, ultrasonics is used for the inspection of blooms, billets and slabs for defects which may harm the final product. Forgings such as shafting, die blocks, rolls and frames are also ultrasonically inspected for internal discontinuities.

Then in the aircraft industry, with its high standards, forgings, extrusions, airframe assemblies and other wrought sections are tested for cracks, segregation, inclusions and other discontinuities which may shorten the life of the part and make it a danger spot.

In industrial plants, quarries, oilfields, railroads, paper mills and other industries, ultrasonics is a valuable tool for preventive maintenance.

Besides its value for finding internal and surface discontinuities, ultrasonics is used to show differences in structure and physical properties and to measure the thickness of metal from one side.

The success of ultrasonics, that is, sounds at frequencies greater than 15 kc per second, depends on two properties of materials. First, the ability of the material to transmit ultrasonic vibrations. (This depends on the material density and its elastic properties.) Second, the piezo-electric effect. This is an ability to convert electrical energy into mechanical energy.

Ultrasonic waves are generated when the electrical energy from a pulse generator is conducted via a co-axial cable to a quartz crystal which (because of its piezo-electric properties) converts the electrical energy to mechanical energy. The crystals are normally vibrated at or near their natural frequency. It is this mechanical energy which forms the basis of ultrasonic testing.

The three commonly used modes of ultrasonic vibration are: (1) Longitudinal (compression) waves, with particles vibrating in the direction of propagation, as they do in audible sound waves; this wave form is probably the one most commonly used because it lends itself to changes of frequency and easy interpretation.

(2) Transverse (shear) waves with particle motion perpendicular to the direction of propagation. (3) Surface (Rayleigh) waves which are propagated on the surface of the material; they are usually composed of both longitudinal and transverse waves.

The common formula for wave motion is $\lambda = \frac{V}{f}$ where V is the velocity of sound in the material under test and λ and f have the meanings given under "notation." The speed of the three waves (which depends on the elastic moduli) are found like this:

Longitudinal wave speed in a rod whose diameter is much less than a wave length (commonly called the thin-rod velocity) is given by this formula:

$$V_0 = 103.5\sqrt{\frac{E}{\text{SP.GR}}}$$

The bulk speed, normally called the longitudinal or compressional velocity, is based on the speed through a medium whose dimensions are much greater than a wave length and is found like this:

$$V_L = 103.5\sqrt{\frac{E(1-\mu)}{\text{SP.GR}(1+\mu)(1-2\mu)}}$$

or:

$$V_L = 103.5\sqrt{\frac{K + \frac{3}{4}G}{\text{SP.GR.}}}$$

And then the transverse wave speed is found like this:

$$V_T = 103.5\sqrt{\frac{G}{\text{SP.GR.}}}$$

Rayleigh surface wave speed can be found from:

$$V_R = 0.9V_T \quad \text{(approximately)}$$

Table 1 shows that the wave lengths of ultrasonic vibrations are relatively short, at about one-half megacycles (mc). If the radiating area of the crystal (transducer) is several times that of a wave length, a narrow beam will travel through a homogeneous material.

When ultrasonic vibrations pass from one material to another, there will be reflections from the boundaries. The amount of reflection depends on acoustic impedance of the material (the product of the density of the material and the speed of the ultrasonic vibration in it).

At the boundary the relation of the incident and reflected energy is:

$$W_R = W_i\left(\frac{\rho_1 V_1 - \rho_2 V_2}{\rho_1 V_1 + \rho_2 V_2}\right)^2$$

When an ultrasonic beam crosses from one material to another, refraction (or mode conversion) also takes place. This is much the same as the refraction of light when passing from one medium to another.

Transverse or shear waves are normally generated when a quartz crystal is mounted on a Plexiglas wedge whose angle with the normal of the crystal varies between 27 and 56 deg. (PICTURE 1).

In the generation of shear waves, because of the difference in speed of Plexiglas and the test material, the longitudinal vibrations passing into the metal will be refracted. At certain angles between 15 and 27 deg., conversion to other modes of vibration occurs, if the ratio of their speeds is greater than unity. So, to work out the mode of conversion, the wedge

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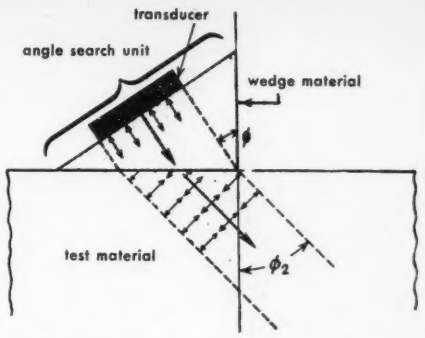
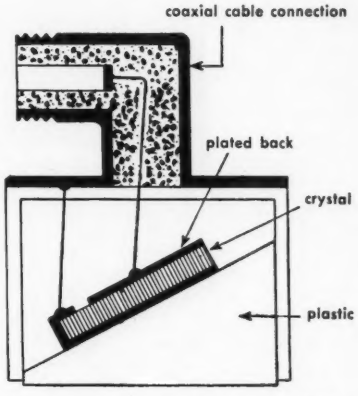
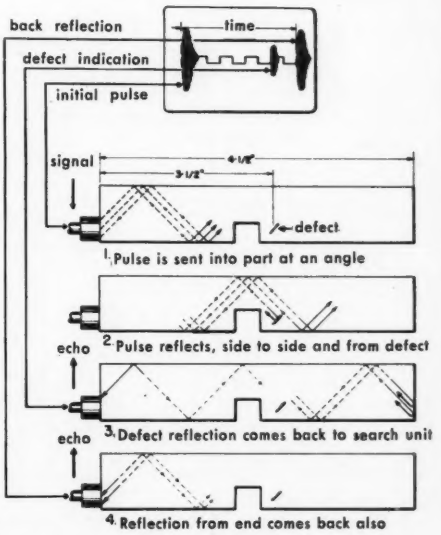


Longitudinal waves are converted and refracted into transverse waves by search unit and wedge.



An angle search unit with crystal plated both sides to get electrical contact between faces.



The whole story of reflectoscope testing in one diagram. Screen reading is shown at top.

Let a Pulse Search *continued*

angle and the resultant inspection angle, the formula used is:

$$\frac{\sin \phi_1}{\sin \phi_2} = \frac{V_1}{V_2}$$

Normally it is wise to choose ϕ_1, so that one mode of vibration predominates. Otherwise it will be difficult to interpret. Commercial transducers, therefore, usually generate ϕ_2 at between 35 to 75 deg.

The sensitivity of ultrasonic testing is settled by the wave length of the mode of vibration. This in turn depends on the speed. So, to get the sensitivity you want, you must choose a suitable frequency. For longitudinal vibration this may be found from Table 1, which gives the speed of ultrasonic vibrations in various materials and the wave lengths corresponding to the frequencies at those speeds. Transmission speeds for other modes of vibration can be worked out from these values by using the formulas quoted earlier.

To get the sensitivity with a shorter wave length (transverse and surface vibrations) the test frequency must be lowered, as shown by the first formula.

Rayleigh or surface waves are generated the same way as transverse waves. However, the wedge angle ϕ_1 in this case varies between 60 and 70 deg. Rayleigh waves penetrate the surface of the test material to a depth one to two times the wave length. At present this mode of vibration is very directional.

The one compact unit of the quartz crystal, the co-axial cable and, wherever required, the Plexiglas wedge is termed a Search Unit. The application of the Search Unit to a surface, with a suitable couplant such as oil, water or glycerin, is the usual method of shooting ultrasonic vibrations at the material under test.

The Ultrasonic Reflectoscope (a Sperry product) generates high-frequency electrical wave pulses of 1 to 50 micro-seconds duration on the Search Unit 60 times a second. The Search Unit, together with a good couplant, is placed on the material and ultrasonic vibrations are projected through the material until they are reflected, all or in part, from the other side — or by discontinuities. The horizontal sweep on the cathode-ray tube shows the time that has passed between the start of the pulse (shown at the left side as a pip) and the moment echoes return. When the crystal is vibrated by the pulse returning from the other side of a material, it generates a small electrical voltage which is amplified and appears as shown on the right of the tube. This is known as the back reflection. But, should a discontinuity reflect the sound, a pip appears between the initial pulse and the back reflection. A square wave superimposed on the sweep is calibrated to measure the distance of the pip from the initial pulse and is used to determine the distance to a discontinuity, or to measure thickness.

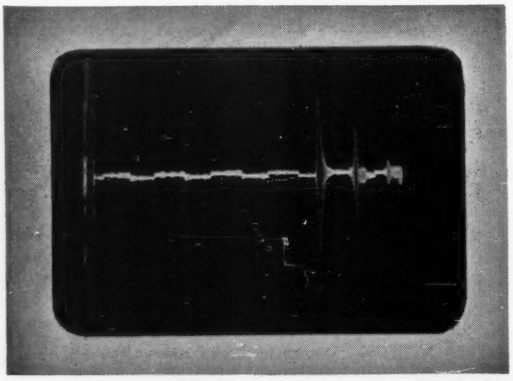
The commonest testing technique is the reflection method, where longitudinal waves are shot normal to the test surface. This method provides inspection for

V_O	=	Thin rod velocity ins. per sec.
V_L	=	Longitudinal wave velocity ins. per sec.
V_T	=	Transverse wave velocity ins. per sec.
V_R	=	Rayleigh surface wave velocity
L	=	Relative longitudinal acoustic impedance computed as V_L x Sp Gr.
T	=	Relative transverse acoustic impedance computed as V_T x Sp Gr.
E	=	Young's modulus
G	=	Shear modulus
K	=	Bulk modulus
μ	=	Poissons ratio
λ	=	Wave length
f	=	Frequency cycles per second
Wi	=	Incident energy
ρ	=	Density
Φ_1	=	Beam's angle from normal in wedge
Φ_2	=	Refracted beam's angle in metal
V_1	=	Velocity longitudinal vibrations in wedge
V_2	=	Velocity vibration in material under test
W_R	=	Reflected energy

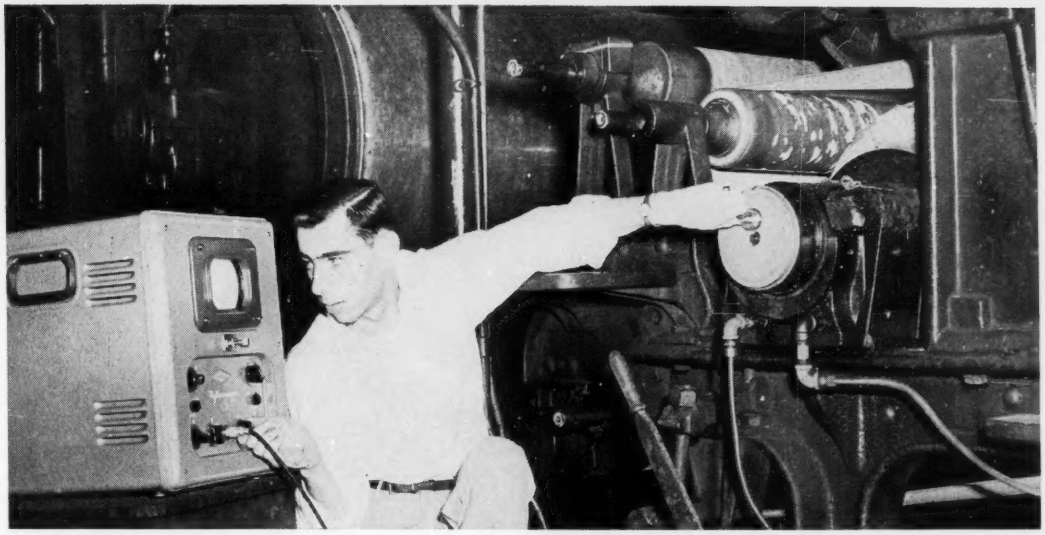
Relations between elastic moduli given by:

$$E = 2G(1+\mu) = \frac{9KG}{G+3K} = 3K(1-2\mu)$$

A crusher shaft, tested in position, was found faulty. When taken out it fell apart — as the picture shows.



An actual trace showing a defect. Left, the marker —right, the return pulse with a defect pulse near it.



A printing press roller was suspected of fatigue. But a brief ultrasonics test (without dismantling) proved it to be sound — and so it stayed in service. Time and money were saved. Why not similar tests for new products?

internal discontinuities such as cracks, inclusions, porosity, lamination, segregation, shrinkages, blow holes and flaking. By this method, testing distance is up to 30 ft. and thickness measured from .25 in. to 30 ft. using frequencies from .5 to 5 mc.

Angle beam testing with transverse waves, (page 37) is an important technique. This is the best way to find flaws in sheet, pipe, tubing and welds. The frequencies used are from 1 to 2.25 mc although higher and lower frequencies can quite well be used. The sensitivity is about the same as with longitudinal waves at frequencies generating the same wave length.

Surface or Rayleigh waves attenuate quickly and must be used on smooth surfaces. They have the advantage, due to the shallow penetration, of traveling over rounded edges or corners from one surface to another. So, fillet areas can be inspected this way.

The through-transmission technique uses both a transmitting and a receiving Search Unit. This is normally a longitudinal wave; it is used where especially large parts are to be inspected or where the reflection method will not penetrate the material. This might be the case, for instance, in large forgings with primary segregation.

Both the reflection and the through-transmission methods may be used in immersion testing. This way, the material to be tested is sunk in oil or, even better, water. Waterproofed search units shoot the ultrasonic vibrations to the material without coming in contact with it. This technique is getting more popular every year.

To locate smaller discontinuities you have to use higher frequencies of from 10 mc. to 25 mc. The transducers used for these frequencies are very fragile and easily break with contact testing. Other benefits are: longer crystal life in lower frequency transducers, rougher surfaces can be inspected; irregular shapes are more easily inspected because the beam can be diverted) and you get semi or fully automatic scanning and

(Continued on page 67)

Check here for wavelengths through some materials

Material	Velocity in. per sec.	Wavelength at frequencies indicated		
		1 mc.	2¼ mc.	5 mc.
Aluminum	245,000	0.245 in.	0.109 in.	0.049 in.
Steel	229,000	.229	.102	.046
Nickel	219,000	.219	.097	.044
Magnesium	210,000	.210	.093	.042
Copper	182,000	.182	.081	.036
Brass	174,000	.174	.077	.035
Lead	84,000	.084	.037	.017
Mercury	56,000	.056	.025	.011
Glass	205,000	.205	.091	.041
Polystyrene	105,000	.105	.047	.021
Bakelite	102,000	.102	.045	.020
Water	57,000	.057	.025	.011
Oil (transformer)	54,700	.055	.024	.011
Air	13,900	.014	.006	.003

For its first ten years the car tried to look like a carriage. GM's plastic Corvette wisely looks like itself.

Do You Look Ahead To Better Shapes from New Materials?

BY CHARLES W. NESS
Fiberglas (Canada) Ltd.

Plastics may fail if they are half understood; but not if their frailties are known. The future is still theirs.

ANY NEW TECHNOLOGY tends to have a tough time in its first year or two, while it's trying to make itself known to designers who are going to use it.

There is a story, allegedly true, of a very high executive in the automobile industry who foresaw snags from the shape of some new models his company planned to produce. When it was explained that there should be few problems since the cars would be made of "fibre glass," he felt better. "Okay then," he said, "just so they don't try to make them with any damned plastic."

You will see the problem. Fiberglas is essentially a plastic.

Most design engineers now know something about what can be done with this resin-and-glass-fibre mixture and what is better done with other materials. It has reached the stage where it can claim to have been proved in practice. Used for the right jobs in the right way, it has a very important place in Canada's industrial future. But an understanding of the material and the manufacturing methods used to form parts from it is quite necessary if it is to serve you well.

Fiberglas reinforced plastic is a resin reinforced with glass fibres. From a wide selection of plastic resins, one is chosen that performs well under conditions of heat, corrosion and mechanical or electrical stress. The resins have a good color range and can be transparent or opaque. Although various types of thermosetic and thermoplastic resins have been used with Fiberglas, the polyester group of thermosetic resins has been used most. The glass fibres contribute mechanical strength, dimensional stability, stiffness and impact resistance; at the same time they complement the chemical stability of the resins and widen the useful temperature range. Within practical limits the properties are improved as the glass content is increased.

Of real interest to the design engineer is the flexible design which the many glass resin mixtures make possible. Not only can the glass resin ratio be varied, but fibres can be oriented to direct strength by a proper choice of the many reinforcements available. This, combined with the newness of the material, poses a problem which only time and experience will solve. Like steel or wood, there is not one set of values to use in designing FRP. Just as there are many types of steel so are

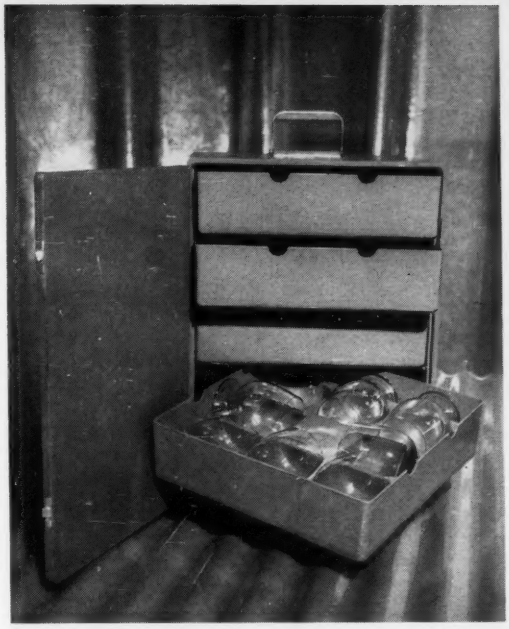
there many combinations of fibrous glass and resins. Failure to realize this has had the material misrepresented as stronger than steel. Some forms are stronger than steel—but other forms are not.

If you look at Table 1, you will see the real story. It compares the mechanical properties of three basic forms of Fiberglas reinforcement. In general terms the mechanical, thermal, optical and electrical characteristics will be influenced by the selection and amounts of fibre glass and resin used. Moldability, chemical resistance, weathering, conventional stability and absence of yield point come with FRP using polyester resin.

It is true that most of the design of FRP parts is done qualitatively at the present time. Fortunately, a prototype can be molded at relatively low cost and this can be used to give design and performance features before production.

In general terms the mechanical, thermal, optical and electrical characteristics will be changed by the choice and amounts of fibrous glass and resin used.

The low temperature and pressure curing of the resins makes it possible to produce large parts with simple equipment. It also means that integrated parts can be molded as an assembly and that cheap molds can be used when a small number of parts is to be made. Because of the low pressures used, moderate to large-scale production can be undertaken for lower tooling costs than with conventional materials. Choice of the mold material and molding process to be used will be fixed by the size, complexity and number of parts to be made. Molding methods are of four kinds, each with its own special uses.



1. *A glass carrier used aboard new TCA Constellations. It is cheaply made but safe, smart, light and clean.*

The contact method uses a mold which may be wood, plastic or a part made from conventional material which is to be duplicated in FRP. The surface of the mold is treated (to make sure the FRP comes away cleanly) and the reinforcement is laid in (or on) the mold. Impregnation with suitably catalyzed and pigmented resin then follows. A sheet of clear Cellophane is placed over this and the air removed by mechanically working the layup. It is cured by placing the whole assembly in an oven, exposing it to sunlight, or allowing it to set at room temperature.

The advantages of this system can quickly be seen. Since the molds do not have to withstand pressure, they are simple and cheap. Design changes do not cost much, very large parts can be made and little extra equipment is required. It is useful in prototype molding for making FRP molds to be used in other molding methods. It is also a quick method of producing a few parts.

But there are many disadvantages as well. It is a messy process and a lot of hand labor is necessary; the quality of the parts varies and the surface is poor. And since pressure is not applied, the process can only

continued ▶

2. *This FRP boat needs no scraping and painting. Its orthodox shape may change for higher speed someday.*

be used when there is a low glass content. This means that the part has a relatively low strength.

Bag molding is a refinement of contact molding. Again, low cost mold material is used, in some cases reinforced plastic. After a contact layup has been made, pressure (or a vacuum) is applied by a flexible bag. In the vacuum system a flexible material is laid over the mold and sealed to make it air-tight. A vacuum is drawn between the plastic sheet and the layup and air is mechanically worked out.

In the pressure system a tailored rubber bag is placed over the mold and clamped in place. Fluid pressure is then applied against the bag. In both cases the part is cured either at room temperature or at elevated temperature by using heat lamps, ovens, and so on.

The process is again messy

The advantages over contact molding are better quality and greater uniformity. A higher glass content is possible because pressure is used. A press is not required and cost is quite low. On the other hand, production rates are slow and the process is again messy. Only one surface—that against the mold—is smooth. The method is useful where higher quality and stronger parts are required in small numbers or large sizes.

Then there is flexible plunger molding. In this process a precision-made heated cavity mold is employed with a solid rubber plunger, both mounted in a press. The reinforcement is placed in the cavity and the resin poured on. The plug is forced into the cavity and the part is cured. The advantages are improved surface finish, high gloss content and absence of voids. A fairly high production rate is possible and slight undercuts are permissible. Limitations are that the process is not practical for large molding, extensive trimming is required and only one good surface is obtained.

Matched die molding is the fourth method. This method employs molding presses with male and female heated molds. It is used for large scale production of parts. The reinforcement is placed in the mold, liquid resin is poured in and then the mold is closed and heat and pressure are applied. Advantages are high gloss content, good surfaces on both sides, accurate dimensions, properties and appearance, less scrap loss and trimming — and lowest cost per unit when taken over the higher production rate. The main snag is the high tooling cost. But molds are still cheap compared with those used to form metals.

That summarizes the main molding procedures used in today's production. One development is the vacuum impregnation method in which male and female molds are made from FRP. The reinforcing matrix is placed dry over the male mold and after the female mold is positioned the liquid resin is drawn up to impregnate the fibre glass from a moat around the mold.

Washing machine tubs having deep complex draws difficult to obtain in metal can be made from FRP and parts can be made integral so that sub-assemblies involving riveting and spot welding are not required. Matched metal die molding gives the required volume and surface characteristics. The FRP tub has a lower heat loss, is lighter than an aluminum tub, will not chip or rust, is easy to assemble and does not require finishing.

The insulated food container (PICTURE 1) is used on the TCA Constellation, the tray being designed to hold glasses safely. The molding technique allows the outer shell, insulation and inner shell to be made in one piece. The tray can be thoroughly cleaned without wetting the insulation. And the molder can made a limited number of containers in different styles because of the low cost tooling involved.

FRP boats (PICTURE 2) are popular because of their lightness and durability. They are leak-proof and do not need springtime scraping and painting. The man-hours saved in construction and finishing keeps price competitive with other boats.

Some big chemical storage tanks (PICTURE 3) were made from Fiberglas recently. There were good reasons for making them this way. Instead of the usual method of building them in sections and making them in either costly stainless steel or in cheaper metal needing the protection of a rubber lining, these were molded in one piece and delivered complete to the site.

Good electrical resistance is another FRP quality. A class B insulation box (PICTURE 4) has just been installed to house switches in a three-phase circuit breaker. It protects the rest of the switchgear from flash-on when the switches open. It has been tested at 40,000 amperes and 4,000 volts, yet it is a quarter the thickness of the usual paper phenolic laminate and much lighter.

There are endless product ideas that could be made with FRP. Why not bowling stands (PICTURE 5) which can be lit from the inside and which stand up to kicks and strikes without damage?

Only a few designers have so far used the full moldability of the material to make radical changes in design which would be consistent with best performance on the water.

Integration of parts (to reduce tooling and assembly costs) is the main feature looked for by today's automobile makers in the production of FRP cars. Highly styled, limited production models are possible, because of tooling cost saving over metal bodies. But only a radical reduction in raw material costs and the discovery of a means to increase production rates will put FRP in the mass-production field. Some big advantages are less weight, localized impact damage that can easily be repaired, no corrosion problems, and fewer rattles and squeaks.

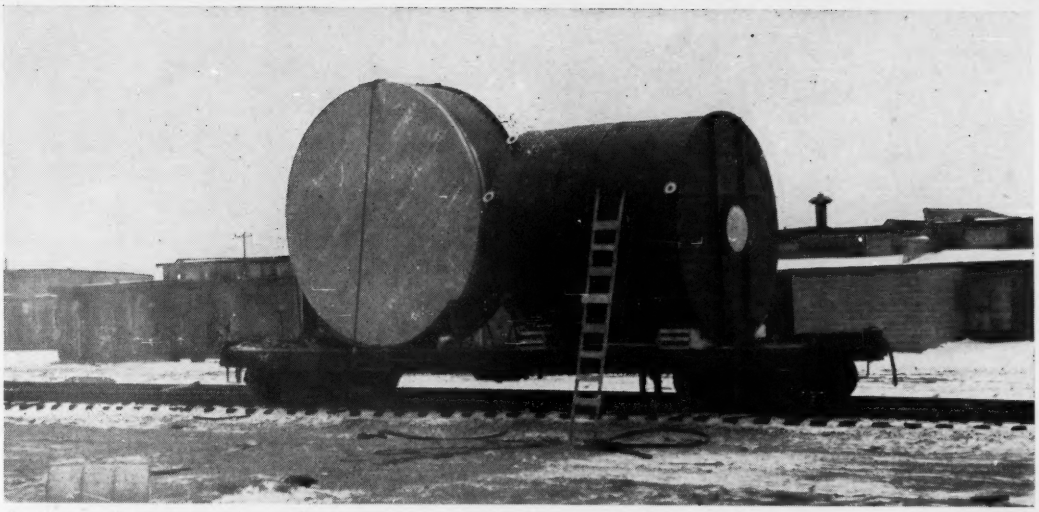
Rounded shapes are strong

Rounded shapes not only look good, they give strength and rigidity and are easy to mold.

To get the best molding results, use maximum allowable draught and avoid undercuts. Draught aids in removal of the part from the mold, allows more pressure on vertical sections and reduces problems of fibre distribution in the sidewalls of parts. A two deg. draught is desirable but one deg. is practicable. As the depth of the part increases, draught should increase.

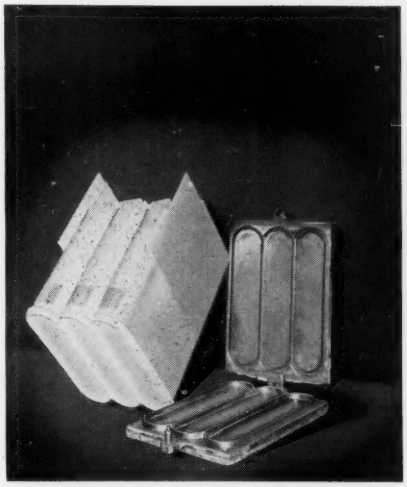
Undercuts can be used in some molding techniques but they present production problems with big runs. Parts are easier to mold if the wall thickness is uniform because abrupt changes in thickness cause poor distribution of reinforcement and produce resin ridge and resin scar areas. For the same reason, if variations are needed to give rigidity, they should be smoothly curved.

Performance thoughts should start with the fact that the yield and ultimate strength are practically the



3. *Huge acid tanks can be made in one piece, freighted as a unit. They are light, strong, need no inner lining.*

FRP offers design engineers 'blood and tears'—and new scope



4. *Five parts take the place of 22 in a class B insulation box made of Fiberglas plastic.*

5. *FRP belongs to playtime too. These bowling stands are lit from inside and brightly colored. Many will be seen in modern alleys.*

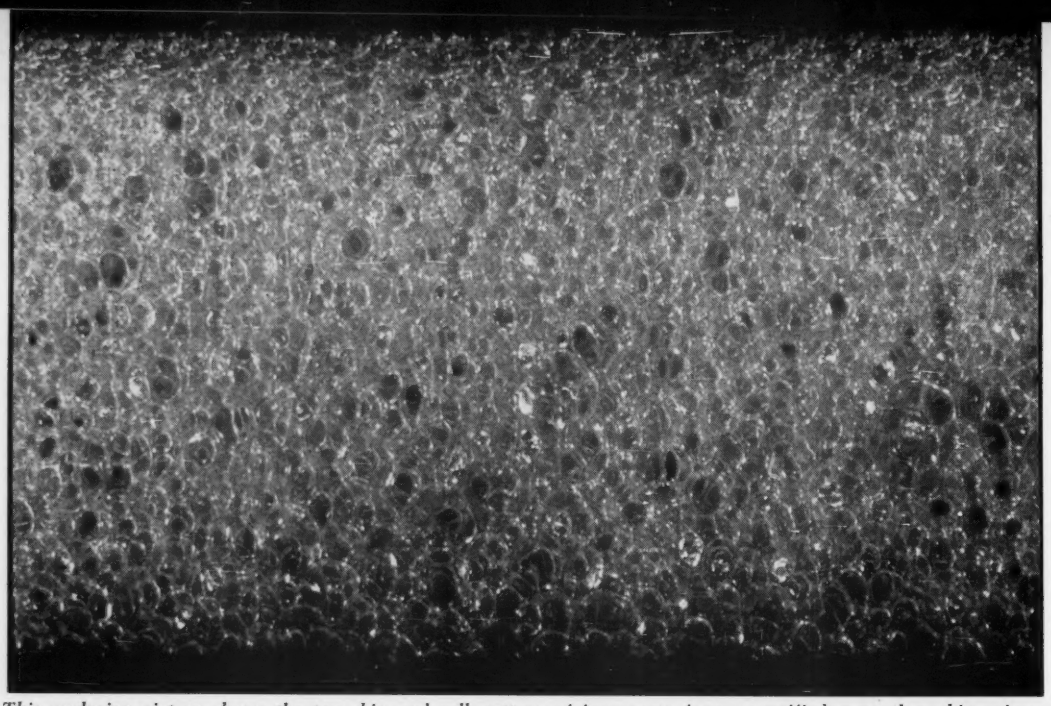
same; so the material cannot take a permanent set. It may rupture but will not stay bent and induced strain is directly proportional to the obliged stress—and when the stress is removed the strain disappears.

Compared with most conventional materials, FRP is not rigid. This is overcome by increasing the glass loading by using flanges, lifts, corrugations, beads, curve sections, and so on. Honeycomb sandwich construction also is effective. It has the added advantage of providing thickness and rigidity without increasing the weight. The advantage of translucence in strong structures should not be overlooked and molded-in color instead of paint finishing is often worth having.

Operating temperatures must be watched and upper limits are often a problem; lower limits are not, since the material appears to increase in strength as the temperature is reduced. Abrasion resistance is not high and the material will show cold flow, or creep, but this is very low. The effect of water, particularly hot water under pressure, is often more of a problem than corrosive acids. This has to be met by using special sizes on the glass fibres to increase wet strength retention.

The economics of FRP materials cannot be stated simply. FRP competes favorably with stainless steel, monel and other special metals and complex aluminum stampings. Then, when the design engineer uses FRP in the right way, it gives less assembly and finishing costs, lighter weight, greater durability and corrosion resistance. Large one piece complex shapes can be made at reduced tooling costs.

FRP offers the design engineer blood, sweat and tears. But we have lived through the period when impossible claims were made for the material — claims based on little knowledge and wild hope. Reinforced plastic parts seldom fail today; they are better understood and better designed. Their future looks good.



This exclusive picture shows the top skin and cell pattern of isocyanate foam magnified more than thirty times.

What is Your Isocyanates I.Q.?

This strong, soft foam began life in Germany five years ago but North America hardly noticed. Now we've got to catch up

BY FRANK CHATTERTON

YOU KNOW NOTHING about isocyanates? Then you should be quick to learn. Most engineers who know them believe that the next half-century's industrial design will be divided into periods of "before" and "after isocyanates." And this is not facetious. For these wonder-products make the production of large and small complex-curved sandwich laminates simple. In doing so, they promise to make us think again about our structural methods.

Karl Kipp, chief designer of a big manufacturing company, put his enthusiasm into words. "I have run out of adjectives and superlatives," he said. "I can't express the possibilities I see for this new product." This comment came after he tested isocyanate foamed cushioning and learned the properties of its related foams.

Foamed-in-place rigid isocyanates are the types which strike very close to industrial design. They have great mechanical strength; they are good heat insulators; and some grades stand long exposure to 450 deg. F without breakdown. (Most other thermosetting resins lose strength, in time, at 300 F.)

A real advantage of these materials is that until just before foaming, they are pourable liquid. If the liquid is poured into the inner and outer skins of an article being made, it foams spontaneously to fill the open spaces. It does so without heat and it bonds tightly to any metal or other surface it contacts. So, when the reaction is complete, inner and outer skins are firmly bonded to a tough, light-weight foamed core.

The reacting mixture is made by stirring two syrupy liquid resins together just before use. One of the liquids is a very reactive substance known chemically as a di-isocyanate. A pure form of di-isocyanate will never be used commercially, because it has vapors which are very poisonous. It is altogether too reactive for unskilled people to handle. The liquid and its vapor react quickly with the eyes, mucous of the mouth, and will necrotize the skin. It will also quickly react with water vapor in the air if left in an open container. This can make it useless.

To overcome most of these problems, the commercial form of di-isocyanate comes partly reacted. In this state it has no poisonous fumes, and is generally much safer to handle. Strangely, it actually works better in its useful reactions in this modified form. There are also some forms of di-isocyanates which are solids at room temperature. But these must be liquefied by heating, before blending.

The second liquid in the resin blend is called a polyester. Chemically, it is related to the well-known alkyd resins used in modern paints. Indeed, paint manufacturers are sure to be active in the field as soon as the products become well known. Like paint, the polyester is safe to handle. It can be stored in ordinary metal containers without harm; when color is used, it will be ground into this resin on regular paint milling equipment as an ordinarily routine job.

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How do isocyanate and rubber foams compare? Study these simple tests

The finished properties of isocyanate will depend mostly on the kind of polyester used. When a foam is wanted — the polyester will be made with an acid number of 35 or better. This way, when the acid reacts with di-isocyanate, carbon dioxide gas is formed. It puffs up the resin to make a foam.

When non-foaming isocyanate products are wanted, another kind of polyester is used. This contains a large percentage of unreacted hydroxyl groups. They combine chemically with the di-isocyanate to form solid resins.

After the two liquids are mixed, it normally takes from one to 10 minutes for the curing reaction to start. It is during this time that foaming mixtures are measured into the cavities where the foam is needed. In a short while, the liquid becomes hot from internal chemical reaction and, right after this, the foams start to bubble and expand like rising bread to from 10 to 30 times their original volume. When the reaction is finished, the foams have a characteristic isocyanate odor for times of minutes or hours depending on the bulk. During this time they cool, and the last traces of reactive material are taken up. The final product is odorless, tasteless, and non-toxic.

The variations are almost endless

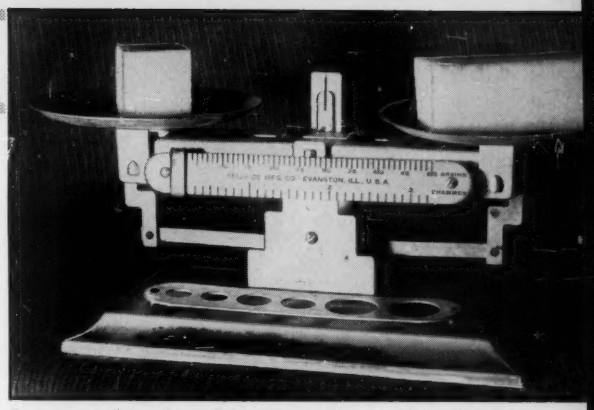
Because of the almost unlimited variations which can be built into the chemistry of the di-isocyanate and polyester, a wide difference in physical properties can be expected in the commercial products. Even with the very limited production going on at present, it is hard to set up valid specifications for isocyanate products.

A case in point is the flexible foams sold by two United States producers. One says isocyanate foams are too stiff at present for cushioning. He is right. *His* foam is too stiff. The second says flexible isocyanates are ideal for cushioning. He is right too. *His* foam makes an excellent cushion. This just shows that specifications will have to be highly individualized.

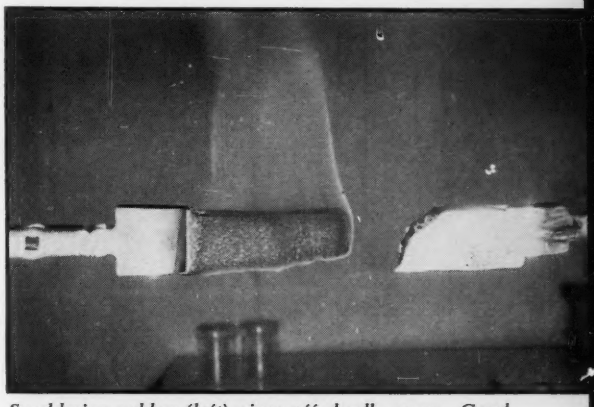
The foams can be made with open or closed cell, or combinations of both, at will. A closed-cell foam can be compared to a cluster of balloons, or soap lather. Both would collapse if the air in the cells escaped. An open cell foam can be compared to a sponge or a piece of pastry. The cell structure of each of these is open; it will allow liquid to penetrate.

Moisture must not be allowed into structural foams used in laminates. This would reduce the insulation value and allow corrosion of the metal skins. It would also destroy a big feature of these laminates — their buoyancy in water. Such core structures will have high thermal and sound insulating values. Light-weight truck bodies, aircraft wings and fuselages, and railroad cars are just some of the "naturals" which can be made with them. Metal skin laminates tightly bonded to isocyanate foam cores have a vast potential.

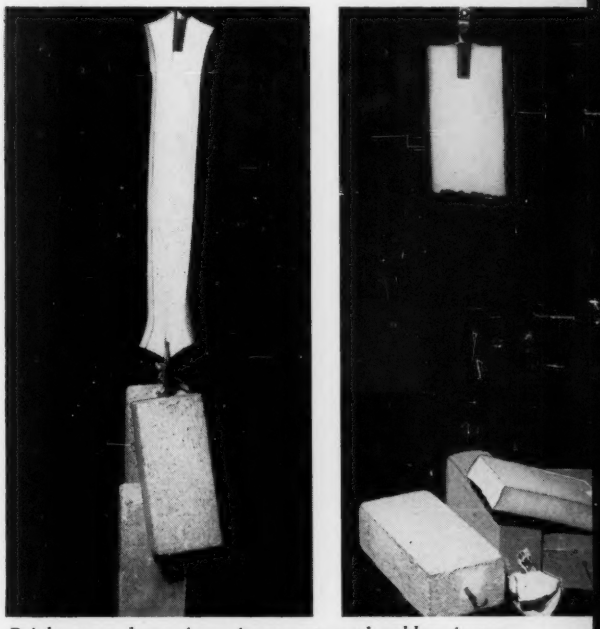
The process will require inner and outer skins which are shaped in advance. These will be held upside down in a suitable jig, and the resin mixture will be poured into the space between. When expansion is complete, and the foam has cooled, simple trimming will finish the structure. As very little joining of metal will be



Isocyanate has about half the weight of rubber foams and twice the cushioning. But volume cost is the same.



Smoldering rubber (left) gives off deadly gases. Good grades of isocyanate (right) resist fire, offer safety.



Bricks were hung from isocyanate and rubber foams, and gave about same stretch. But the rubber soon broke.

continued

needed, it is of value to note that corrosion around rivets, and at contact with inner framework will be greatly reduced.

Isocyanate foamed cushioning will work great changes in the furniture industry. This material has half the weight of foamed rubber, and twice its cushioning effect.* The cost is about the same on an equal volume basis.

With double the cushioning of rubber foam, only half the thickness of the new flexible resin foam is needed to do the same job. As its price is the same on an equal volume basis, it might be thought that its use would halve cushioning costs. But for the present, this is not true. Though savings can be made, rubber takes up some of the difference in cost, because it is cored. Isocyanate cushioning is molded in solid blocks, and cut to finished shapes afterward.

Strangely enough, it is the great versatility of the isocyanate foams that makes this molding in solid blocks necessary. Because they are so little known, producers are forced to make as many different products as possible at minimum tooling costs. With the market undeveloped, it is cheapest to make a multitude of products from a single mold. There is no doubt they will soon be molded on an individual basis.

It feels weird to the touch

First contact with an isocyanate foam cushion is a weird feeling. On being touched with the finger tips, it feels so firm it is hard to believe it will be comfortable to sit on. But it is. The effect is exactly the same as sitting on a feather bed. The downy sensation is quite unlike the one you expect.

Makers of the new cushions explain this condition by comparing the nature of the foams to that of rubber. It is due, they say, to the fact that the cells are half open and half closed. Rubber cushions are composed of foam that is all open. The effect is a result called "swimming" and "fight back." It is caused by the way in which thin wall sections of rubber bend under compression.

Isocyanate foam, being less dense than rubber, has its cell walls much thinner. As a result they have a nature which might be called limp. A cushion made entirely from this kind of foam with open cells would collapse under pressure, and give little support. This would be true, even though (like rubber) it would recover its shape after the pressure was removed.

On the other hand, flexible isocyanate cushion made entirely from closed cells would have a tighter springing effect than rubber. This would be caused by the gas under pressure in the tiny cells, each behaving like a tiny rubber ball. A combination of both kinds of cells blends the soft "give" of the open cells with the support of the closed.

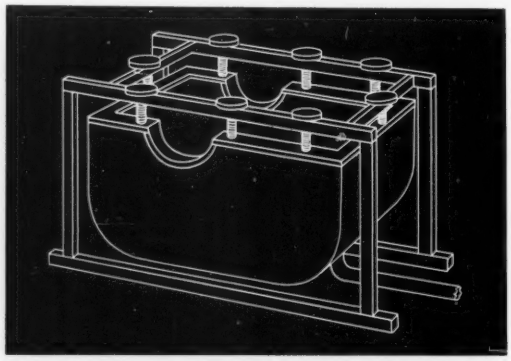
This new cushioning has a rich future in cushioned seats and mattresses — not only for the added comfort it brings, but for other advantages as well. Good cushioning grades of isocyanate will char in a fire, but will not keep on burning after the flame is removed. And when charred, they do not produce toxic gases or fumes. Smoldering rubber, on the other hand, can produce deadly hydrogen sulphide gas, and wool hydrogen cyanide. It is agreed by fire authorities that smoking in bed is one of the most common forms of self-destruction due to fire. Most of the victims are asphyxiated by fumes from the smouldering mattress before the fire destroys them. The use of isocyanate mattresses will greatly reduce bedroom fire hazards.

Other gains are made in fabricating the new cushion. Isocyanate does not shed, and has very high tensile strength. Depending upon the grade and quality of rubber considered, it is from three to five times as high. Its great toughness is shown by its use as "topper pads" applied directly over springs in German automobiles.

In addition to its advantages when used as a straight replacement for rubber, the new foam opens up an entirely new concept in cushion construction. It has long been the dream of seat manufacturers to turn out a finished product right from the mold. Since the isocyanates form a surface skin against the surface of the mold during formation, they provide a way of making this dream a reality. Skin thickness can be varied by coating the mold surfaces with a heavy film of non-foaming flexible isocyanate coating, before the foaming resins are put in. A release agent is put on the mold surface to prevent sticking.

Flexible vinyls are now widely used as seat coatings. No doubt the first one-piece seats and cushions will be made with vinyl surfaces. This can be done by first fusing a vinyl plastisol to the inside surface of the mold. The method will be identical to that used in making "human skin" toy dolls. The liquid plastisol, having the consistency of mayonnaise dressing, is poured into the mold, which is closed and rotated in an oven until the liquid sets to a flexible skin. For larger moldings, no doubt heat will be supplied from heaters attached to, or cored into, the mold wall.

After the seat skin has been slushed and cured into the mold in this way, it will be punctured in a suitable spot, and the correct amount of foaming isocyanate resins measured in. During the foaming, the isocyanate will bond tightly to the vinyl. The mold will be designed so that this puncturing can be done without opening it. After the foaming is complete, the finished cushion can be removed. There is no problem of loss of adhesion between the vinyl and isocyanate due to plasticizer migration — which some people expect to find.



Will this foam revolutionize body building? It might. Bodies may soon be molded — like this.

*By the Rubber Manufacturers Assoc. of the U. S. cushioning test.

No doubt many variations of this technique will be used. It is not hard to visualize a one-piece chair with the frame molded right into the cushion. Low cost, large-size molds such as used for making reinforced plastic boat hulls could be used for this purpose. It would be necessary to design them so that the chair frame could be set into the mold and the isocyanate foamed around it.

A further feature of value is that vinyl upholstery stock can be electronically bonded to isocyanate cushioning. To do so, the vinyl stock is laid over the isocyanate cushion and compressed between induction plates. The method is almost the same as that used in making plywood veneer, the difference being that only a fraction of the pressure is needed. The electrode in contact with the vinyl stock may be water-cooled. This keeps the surface cool when the current is turned on, and the high frequency field between the plates creates heat at the interface between the vinyl and the foam. This causes the vinyl surface to become hot and tacky, and bonds it to the foam. When the pressure is released, the cushion regains its original shape. The high resistance to heat distortion possessed by this foam alone makes such a process possible.

For a less costly approach, cold gluing with flexible isocyanate adhesives could also be used. For this, it would be necessary to have some sort of form to hold the vinyl against the foam while the adhesive sets.

There are exciting possibilities

These facts are full of exciting possibilities. Due to reduced labor, manufacturing costs of most of these items will be much less. Due to increased toughness, the finished products will have more uses than present cushions as well.

Other goods which could be made using the process include such things as cushioned floor tiles, and one-piece insulated boots. Insulated containers (such as an improved version of the time-honored thermos bottle), dolls and mannequins, crib mattresses with wet-proof skin, and acoustical hoods for motors are but a few of the things that come to mind.

A few body manufacturers, for instance, have thought about using these foams instead of frames. One, an experienced company, has given some rough figures for a trailer body, 32 ft. long by 8 ft. wide.

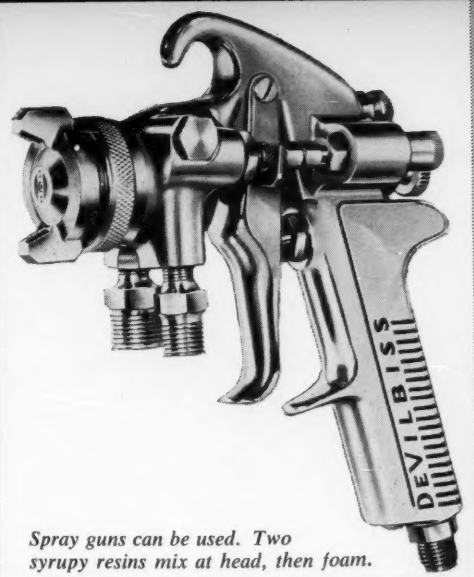
By the old method, labor in making the framework would come to about $250 and cost of materials would be close enough to $300. So, it would cost you $550 (without the outer skin) to build.

Against that, for foam construction, labor in setting up the inner and outer skins would cost about $25. The foam, at 1 in. thick, would cost, roughly, $340. So the new total is $365 — a saving of $185.

But there is more to it than this. There would be a weight saving of some 500 lb., worth no less than $2,500 to the carrier when his trailer has covered 250,000 miles — a quite usual life.

Isocyanate adhesives make excellent metal-to-metal bonds. There is every probability that they will replace rivets for many purposes. Joints between materials having widely different physical properties can be made. These include any combination of glass, plastic, rubber, and metals. And electrolytic corrosion will stop when these glues are used to bond unlike metals.

Dissolved isocyanates in solvents are finding a useful place in the coatings field. They may be pigmented by milling colors into the polyester part of the two liquid components. Like other isocyanate products, the two liquids are mixed just before use. But unlike the other products, they are made to set slowly, being usable for up to three days after mixing. Their useful life is finished when they set to a gel in the container.



Spray guns can be used. Two syrupy resins mix at head, then foam.

A modern method of using such coatings is by means of a double liquid spray gun. There are a number of models of these guns. All draw two liquids by separate hoses up to the spray head. Here they are combined either just before, or just after atomization. One such unit is equipped with a heating chamber which warms and thins out viscous liquids. This gun is very useful in spraying isocyanate foam insulation.

The United States navy is now testing such foam on the inside of boat hulls to stop condensation. The foaming resins arrive at the hull surface as liquids. Here they start the regular foaming-setting-adhering process whereby a tough foam up to two inches thick can be built up. Great savings in weight and installation cost, and a longer insulation life are expected.

Isocyanate coatings, both foaming and regular, are noted for great chemical resistance, toughness, high gloss, and adherence. Their electrical properties are good, and are enhanced by the low moisture absorption of the film. They have excellent heat resistance — approaching that of silicones. Acids, alkalis, greases, and most other destructive chemicals have little effect upon them. The coatings set at room temperature. Baking is not needed.

An amazing solid rubber is the last product spawned from this wonder material. This substance has phenomenal power to resist abrasion, solvents, and heat. It is higher in cost than ordinary rubber but, since tires having a tread life of over 100,000 miles can be made with it, cost per mile in use will actually be lower.

There are certain synthetic rubbers which will react with di-isocyanates to improve. Perhaps our first use of isocyanate rubbers will be as modifications of our present materials. But there are many cases where reduced maintenance changes will make the use of pure isocyanate rubber of immediate interest, despite first costs.

Having the broad nature of other isocyanate resins, the rubber should be useful for tank linings, conveyor

(Continued on page 72)

continued ▶

Try Using the Column Analogy

- ***Here is a beam-figuring method that deserves to be better known. If you have never done so, try using column analogy now for solving fixed beams, portal frames, arches and so on.***
- ***This article shows how the method can be used to solve fixed beams of either constant or varying cross-section, and with any system of loading where axial loads do not exist.***
- ***Column analogy can become a very useful tool***

BY WILLIAM MORSE

Engineering Editor

COLUMN ANALOGY is an easy method to use for finding the end moments on fixed beams of constant cross-section. It works for any loading pattern.

Of course, if the loading follows a simple pattern, it is only necessary to look up a standard work of reference. And other conventional but not so often quoted cases can also be got from standard data.

But when it is not possible to approximate the actual loading by applying two, or more, conventional cases—why not resort to column analogy?

A fixed beam (PICTURE 1A) loaded as shown and spanning 20 in., is an example. Tackle it like this:

Plot the free bending moments (Ms) assuming that the beam is simply supported at the ends (PICTURE 1B). Follow this by finding the area under the free BM curve, which is:

$$\sum M_s dx = 1224$$

Now find the spanwise position of the centroid of the free BM curve (PICTURE 1 B). This is given by the distance from A:

$$\bar{x}_A = 9.78 \text{ in.}$$

Then:

$$\phi = \frac{1}{EI}\sum M_s dx = \frac{1224}{EI}$$

This is because E and I are constant. Now you are ready to draw the analogous column (PICTURE 1C). It is a rectangle of constant width $\frac{1}{EI}$ so that:

Area of analogous column $A\ col = \frac{20}{EI}$

The second moment of the analogous column about centroidal axis YY, located at half-span is:

$$I_{COL} = \frac{1}{EI} \cdot \frac{20^3}{12} = \frac{667}{EI}$$

$$M_A = \frac{\varphi}{A_{COL}} + \frac{(\phi \times \text{offset})y}{I_{COL}}$$

offset = .22 in. from Picture 2.

$$\varphi \times \text{offset} = 1224 \times .22 = 269$$

$$M_A = \frac{1224}{20} + \frac{269 \times 10}{667}$$

$$= 61.2 + 4.03 = 65.23 \text{ lb.-in.}$$

$$M_B = 61.2 - 4.03 = 57.17 \text{ lb.-in.}$$

Note that the EIs cancel out. The resultant BM on the beam is shown shaded (PICTURE 1B). It can be shown that for a fixed beam carrying no lateral load (PICTURE 3), if the end B sinks an amount δ relative to A, the end moments induced are:

$$M_A = \frac{6EI}{L} \cdot \frac{\delta}{L} \text{ Top flange in tension}$$

$$M_B = \frac{6EI}{L} \cdot \frac{\delta}{L} \text{ Top flange in compression.}$$

These end moments must be superimposed on those resulting from any lateral load and, for a continuous beam, incorporated in the moment distribution calculations.

For the purpose of moment distribution calculations, remember that the stiffness at B of an nontapered beam AB is:

$\frac{4EI}{L}$ for both ends fixed

$\frac{3EI}{L}$ for A pinned and B fixed.

The carry-over factor is .50.

The end moments for a beam of varying cross-section too, can be found quite quickly by column analogy. In fact, it is hard to think of a better method.

Take the tapered beam (PICTURE 4A) which has unit width. At various spanwise stations along the beam, find the value of the moment of inertia I and 1/I: Plot 1/I to give the shape of the analogous column (PICTURE 4B).

Find the area of the analogous column, the position of its centroidal axis YY and the moment of inertia about YY. The working is not shown but the results are:

$$A_{COL} = \frac{.7162}{E}$$

$$\bar{x}_{COL} = 6.71$$

$$I_{COL} = \frac{20.12}{E}$$

Now plot the free BM curve assuming that the beam is simply supported at the ends. This will be a triangle with maximum ordinate 480 lb.-in. under the load at C (PICTURE 5A).

By tabulation find the ratio $\frac{Ms}{I}$ at the same spanwise stations as above, plot $\frac{Ms}{I}$ (PICTURE 5B) and find the area under this curve. Then:

$$\phi = \frac{1}{E}\sum \frac{M_s}{I} dx = \frac{144.8}{E}$$

The position of the centroid of the $\frac{Ms}{I}$ curve (that is, the position where ϕ acts) is at 8.94 in. from A (PICTURE 5B). It is now possible to find the end fixing moments like this:

At A.

$$M_A = \frac{\phi}{A_{COL}} - \frac{(\phi \times \text{offset})y}{I_{COL}}$$

offset = 2.23 in. (Picture 6)

$$\phi \times \text{offset} = 144.8 \times 2.23 = 322.5$$

$$M_A = \frac{144.8}{.7162} - \frac{322.5 \times 6.71}{20.12}$$

$$= 202 - 108 = 94 \text{ lb.-in.}$$

Method for Solving Fixed Beams

At B.

$$M_B = 202 + \frac{322.5 \times 13.29}{20.12}$$
$$= 202 + 212 = 414 \text{ lb.-in.}$$

For a tapered beam, the stiffness is not given by the ratio $\frac{4EI}{L}$ or $\frac{3EI}{L}$ as the case may be.

To find the stiffness at A, which, by definition is the moment that must be applied at A to cause unit change of slope there, put $\phi = 1.0$ in the column analogy formula.

Stiffness at A:

$$= \frac{1.0E}{.7162} + \frac{6.71 \times 6.71E}{20.12}$$
$$= 1.4E + 2.25E = 3.65E$$

Moment induced at B

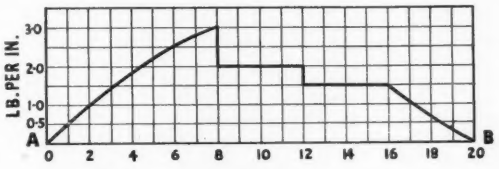
$$= \frac{1.0E}{.7162} - \frac{6.71 \times 13.29E}{20.12}$$
$$= 1.4 - 4.44 = -3.04E$$

Carry over factor A to B

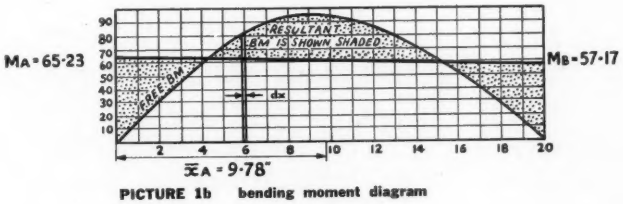
$$= \frac{3.04}{3.65} = .83 \text{ and not } .50$$

as it is for a non-tapered beam.

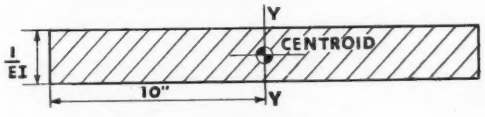
Proceeding in this way, a design chart like the one shown on page 64 can be drawn up to give end moments, stiffness and carry-over for any straight-tapered beam carrying a concentrated load W.



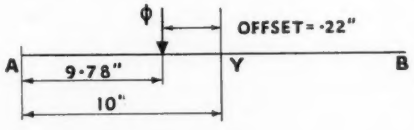
PICTURE 1a loading diagram



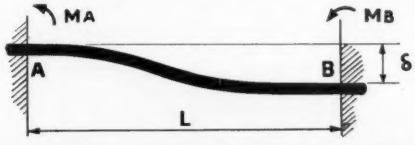
PICTURE 1b bending moment diagram



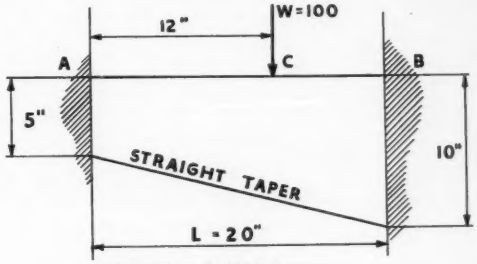
PICTURE 1c analogous column



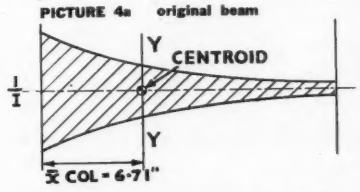
PICTURE 2 measurement of offset



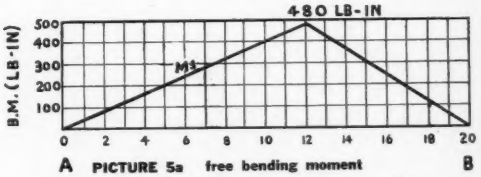
PICTURE 3 fixed beam with sinking support



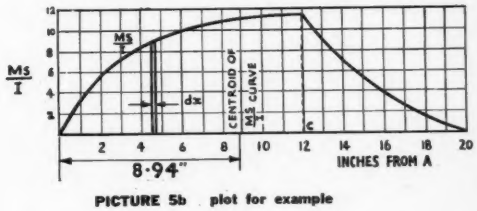
PICTURE 4a original beam



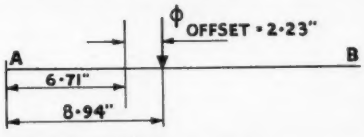
PICTURE 4b analogous column for tapered beam



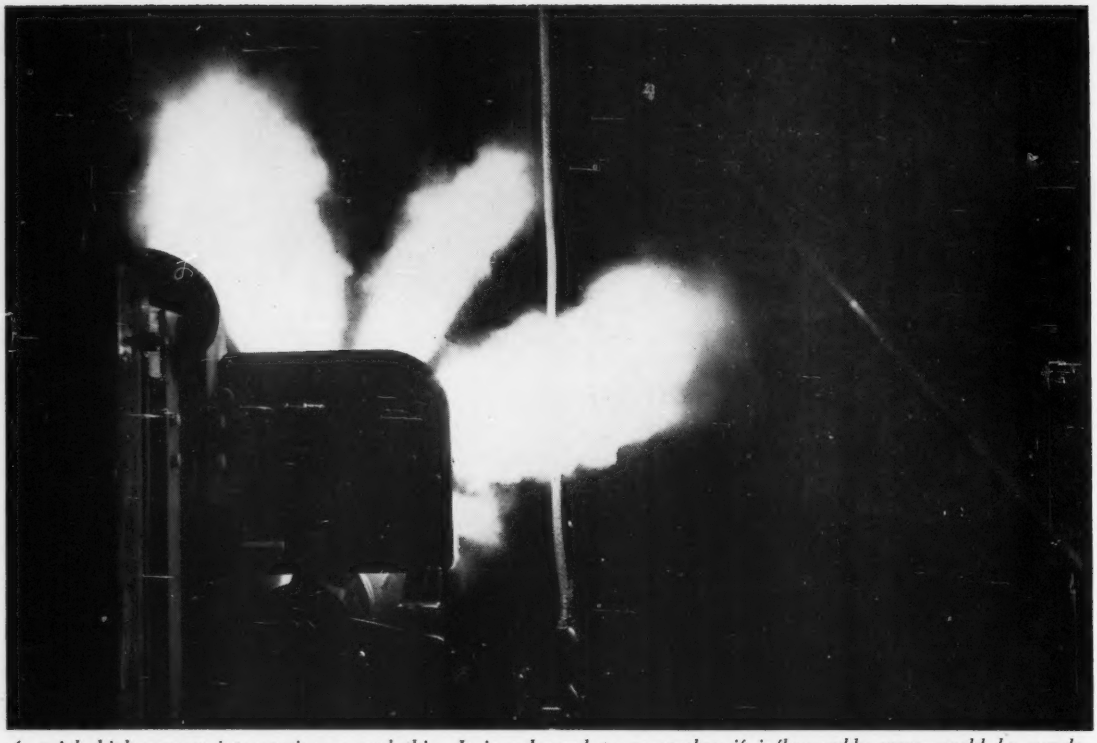
PICTURE 5a free bending moment



PICTURE 5b plot for example



PICTURE 6 measurement of offset



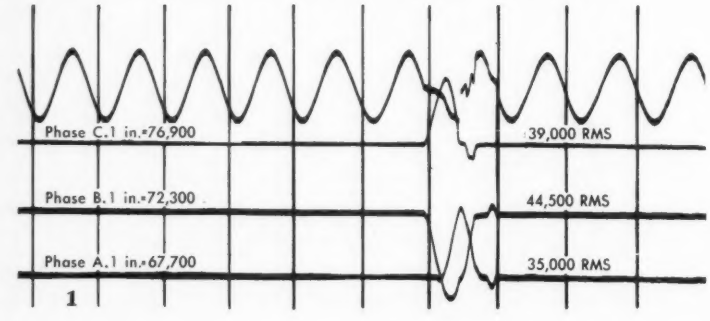
A quick high-current interruption caused this. It is a hazard to remember if inflammable gases could be nearby.

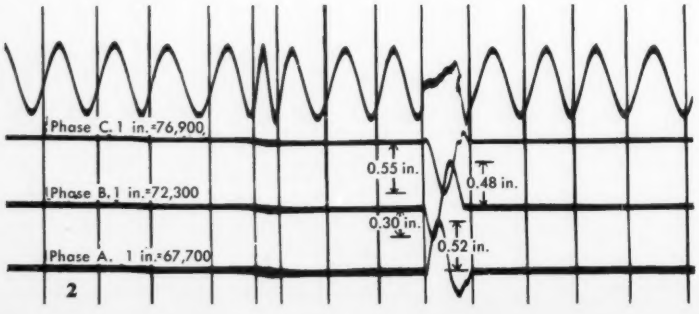
Think of Heat when you Make a Breaker

Flame and impact are the enemies

BY W. J. GILSON

Eastern Power Devices Ltd.





IT IS PART of a circuit breaker's job to stand up to terrific punishment. It must survive huge heat impact and mechanical forces which act like a drop hammer blow under the well-known acceleration from magnetic fields.

Few engineers dealing with broad design have time to keep up with the complex test methods used by today's development engineers in the effort to make breakers that are tough, efficient and safe. Poor, or optimistic diagnosis of test results can have far-reaching effects; the test engineer's decisions play a big part in design.

The question of rupturing capacity under short circuit conditions is the big factor in air circuit breaker design; it overshadows everything else.

So the short circuit test is the brutal proving ground for design in breaker construction. It is an integral part of the development engineer's design technique.

Then the interpretation of values leads you into a very specialized study which we shall look briefly at now.

Testing procedure for 600 v air circuit-breakers, which usually operate in less

than 2 cycles of a 60-cycle system, is a very tricky business. To obtain a reasonably common yardstick, the development engineers in Canada follow the rules laid down in AIEE Standard No. 20, covering low voltage air circuit-breakers. This calls for a carefully calibrated test circuit to be set up in line with ASA Standard C-37.5-1945, the RMS test value of current to be measured at a half-cycle after the short circuit occurs.

Calibration of the test circuit is made without the breaker to be tested in the circuit. After calibration to get the right test value, the circuit is opened up and the test breaker put in.

Calibration of the RMS value of current, covering a short circuit value which may be cleared at the first current zero, is a rather difficult and arbitrary matter, and a study of the oscillographic record a job for experts only.

A test record of an unsuccessful breaker (PICTURE 1) rated for 50,000 amperes rupturing capacity is shown here. This cleared 35,000 amperes on phase A, 44,500 amperes on phase B and 39,000 amperes on phase C, at what can be described as the first current zero.

In the tracer calibration the values for 1 in. linear measurement are shown for each phase and the test values worked out.

The good analyst would view the short loops on the current tracers (before full voltage was established across the open contacts) with apprehension. These loops represent "restrikes" or re-establishment of arcing after the breaker had opened the circuit on all three phases.

To the development engineer this means that there is some serious design fault which is not allowing the ionized gases to get away fast enough. This may mean a faulty blow-out coil, faulty shaping of arc splitting materials or faulty arc chute design. Or it may mean all three.

Current value analysis is a compromise; it can be very easily interpreted to give varying values. For example, the oscillogram also shown (PICTURE 2) shows a breaker opening at almost exactly the half cycle mark on phase C and shows a full cycle in phases A and B. Here is evidence of a restrike on phase C, shown by the short loop which follows the short axis line. To analyze the true current values interrupted needs some assumptions. Certainly there is not enough current value or wave shape on the oscillogram to allow the drawing of an envelope over the wave shape, as described in AIEE, ASA, or CSA standards for oil circuit-breakers. Nor does it permit analysis of an asymmetrical wave by the established definition that RMS value is:

$$\sqrt{(\text{RMS SYMMETRICAL})^2+(\text{OFFSET})^2}$$

Looking at the three different wave shapes (PICTURE 2) it is obvious that any figures for an offset value will have to be rather sketchy.

A good method of analysis to find the RMS value of an asymmetrical sine wave of a single loop form is given in Appendix A, AIEE Standard No. 22, July 1952. One large loop and a minor loop (PICTURE 2) show on phase A. On phase B there is a minor loop followed by a major loop, and on phase C a major loop followed by a short current zero and then a restrike of small proportions.

Measuring from the neutral axis on the first loop of phase A gives 0.52 in. On phase B on the first minor loop half cycle gives 0.30 in., and on the second loop 0.48 in. On the main loop in phase C the measurement is 0.55 in.

Take the last case (phase C) as having the largest offset value use current N from Appendix A (previously cited) and

$$\frac{A}{B} \times 100 = \frac{0.30}{0.53} \times 100 = 56.6$$

From the curve, N = 0.7 and so the RMS value is:

$0.7 \times 0.55 \times 76{,}900 = 29{,}600$ amps.

Making a single loop analysis of phase A:

$$\frac{A}{B} \times 100 = \frac{0.25}{0.53} \times 100 = 47.2$$

therefore:

$$0.707 \times 0.52 \times 67{,}700 = 24{,}900 \text{ RMS amps.}$$

Taking the major or second loop on phase B gives a measurement of 0.48 in., but in this case there are two loops approximating a sine wave to contend with. This is still not enough wave form to draw an envelope but is more than in the single loop procedure used so readily for phases A and C. For this case, use the method used by the U. S. Underwriters Laboratories.

For a one-cycle fault with two loops in a one-cycle wave, they use an "a" and "b" measurement of the two loops for the vertical dimension of the major and minor loops respectively and then go on like this: RMS=

$$\sqrt{\left(\frac{a+b}{2.828}\right)^2 + \left(\frac{a-b}{2}\right)^2}$$

This method should not be used when the minor loop comes first, but with no other recognized method to fit the case of phase B (PICTURE 2) and using the analysis of the other two phases as a guide, the Underwriters method in this case is probably close enough. It works out to 21,000 RMS amperes.

The need for a very comfortable margin over analyzed test values is real.

The modern air circuit-breaker has become a very reliable protective device. Having no oil to contaminate (carbonize) it can be operated against short-circuit currents within its rating with much greater safety of repeated operations. A study of the photograph here, however, is a reminder that hot luminous gases do get outside the arc chutes at the higher current interruptions — even on a conservatively designed breaker. It is worth remembering for open type installations in gas plants or other like areas.

In Confidence

FREE-LANCE DESIGNER James Booth in 1924 offered a design for a new car to the Stutz Motor Car Company of Indianapolis, makers of the famous Bearcat. The "application of true artistry to cold mechanism," was how he described it. And he showed them a third of a mile of drawings—in confidence.

The Stutz management looked at Booth's drawings, wavered for a time, finally turned down his offer. Going ahead on its own, the company produced the 1926 model of the Bearcat.

Booth had taken out a patent on the main features of his design—a low chassis and driving mechanism which put the floor near the ground. He found out that this idea had been used in the new Stutz car, and he thought the car had some other features of his design too.

So he sued Stutz for infringement of his patent and for breach of confidence, arguing that Stutz had taken features of his design as well as his invention.

Pointing out that the low-drive idea had been known for 20 years, Stutz attacked Booth's patent. And the judge ruled that the patent was no good.

"But that is only part of my case," came back Booth. "My design was submitted in confidence, and the law says that features shown in confidence must not be taken even though they cannot be patented."

The court agreed. The success of the Stutz car, it decided, was partly due to non-patentable details of Booth's design. There was no deliberate copying, but Stutz would still have to pay heavy damages.

Cases like this have made management cautious. Many ask inventors to sign contracts before they look. (Contributed by Roy V. Jackson.)

Quality finishes come cheaply from flow coating and dipping—the modern methods for tomorrow's big production runs.

'Flowcoat' for Tomorrow's Finishes

Few Canadian paint shops use up-to-date methods. Yet modern techniques give better quality at a lower cost.

BY H. E. EMMETT

Glidden Co. Ltd.

IT IS TIME Canadian industry took a more careful look at flow coating and dipping for paint finishes. These two methods can very often push down production costs and at the same time give a better quality job.

Flow coating means squirting liquid paint onto the product, rather as you would hose down your car. (It is not the same as spray painting, the paint is not atomized by compressed air as it leaves the hose head.) Dipping, of course, means exactly what it says.

Neither of these methods is really new. Yet they are not very often used in Canada and when they are, they are not always used very efficiently.

But automobile engineers have had much success with flowcoated primers on fenders, hoods and other parts and electrical people have found the method good for painting big transformers. Smaller things, like chairs, cabinets and toys are quite commonly being dipped and they are ideal products for this process.

Of course both these methods have their drawbacks—there is no point in pretending that just left to themselves they turn freely into a plush panacea for painters. There are some very large products, for instance, that flowcoating might not cover too well, and for these automatic spraying would possibly be a better method. Then, dipping (if it is to be properly used) takes huge amounts of paint in up to 5,000 or even 6,000 gallon tanks—and so sets up fire and weight problems. On the other hand, flowcoating and dipping have a great deal to offer.

Canada's bright industrial future is dimmed a little by high production costs. Finishing is part—quite a big part—of those costs and modern methods can help to make it better and cheaper.

Our industry is reckoned as being still young. This may be close enough to the truth, but it is also true that many of our finishing shops are suffering from old age. Most of them were designed and built years ago and now find themselves being overtaken by new technology and big production runs.

Paint manufacturers have often been unable to supply the best materials to industry because they have had to allow for the fixed production methods and schedules of outdated finish departments. But whose fault is this?

There is no doubt that it is at least partly the paint manufacturers'. They have been slow to urge the use of new equipment while knowing that new methods needed it. "You can't eat grilled steak with a soup spoon," is how one paint executive acknowledged this in an after-dinner speech. Paint manufacturers offered steaks but failed to see a shortage of knives.

Three partners are involved in finishes. The equipment maker, the paint maker and the user. In the past, liaison between them was poor.

Today it is much better. When the war forced industry into high gear production the dilemma of the soup spoon paint shop was noticed. There have been very big improvements since then.

Paint technology has more than kept pace with industry. In recent years, the new epoxy resins have arrived which allow the users of organic surface coatings to re-design their finishing systems for more and better products at reduced paint and labor costs.

Epoxy primers give thinner, more resistant films than older primers. Even using conventional methods, costs will come down with the new resins. For one thing their hardness means that no finishing coat is needed on surfaces that will not be seen. When further economies

from better production are added, the saving can grow into a large percentage.

Assume, for example, that you want to cut the cost of automatic washers.

It is usual today to spray primer on all inside and outside faces, then to bake, scuff, sand and recoat with topcoat.

Using this old system for a 200 run (see TABLE) the cost of primer would be $1.66 and the cost of enamel $2.08 —a total for each unit of $3.74.

But if you flowcoat with, say, Nupon primer before spray enameling for the finish, your primer costs goes down to 53½ cents and your enamel cost to $1.04. This gives a total of $1.57½—or saving per unit of $2.16½—which is $433 a day.

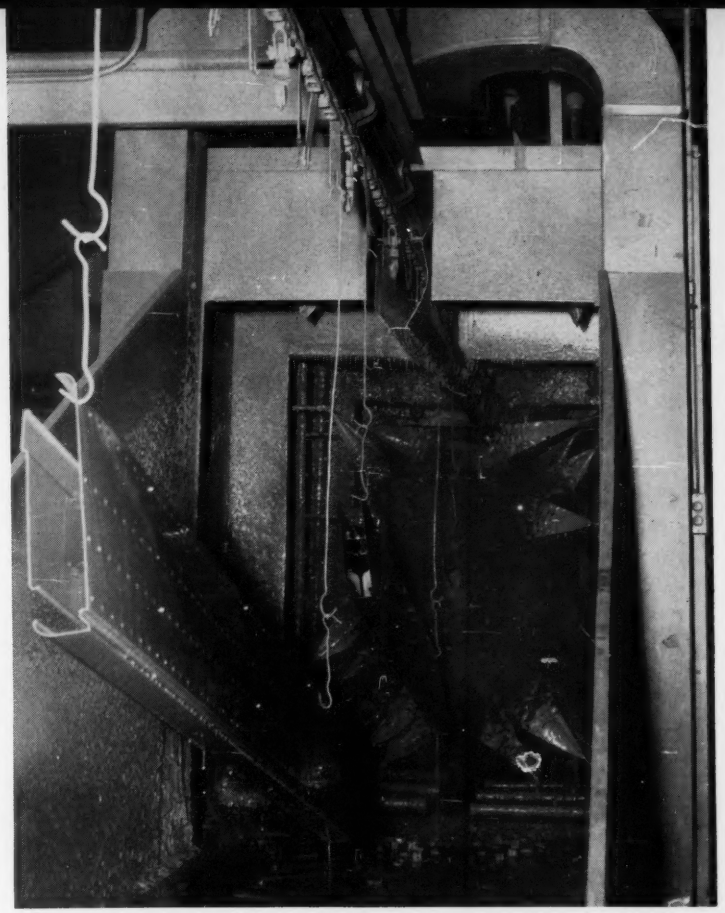
To be very honest about it, that figure is a shade optimistic. It does not allow for the cost of solvent. The older system would use 42 gallons of reducer at 60 cents a gallon, which gives $25.20.

By flowcoating, about 34 gallons of reducer for the primer at $1.00 and 11 gallons of top coat thinner at 60 cents a gallon would be used. This adds up to $40.60—a difference of $15.40.

If you take this away from the saving you are still left with the very worth while cost reduction of $417.60 for paint alone.

Labor costs are lower with flowcoating too. About $80 a day on the same 200 run would come from reduced labor. To this, add savings from the cost of spray booth maintenance and of heating the air supply to one booth—and you have the kind of economy that most washer makers would find a very agreeable experience.

For production runs of less than 200, it would usually be better to dip than to flowcoat. With some exceptions, dipping will work very well on products suitable for flowcoating. Manufacturers using dip tanks which are not up to date, would be surprised at the results which can be had. But the tank should have viscosity control, automatic filtering, correct withdrawal speed and proper detearing equipment. Not many have all this. It is a pity that few tanks have been well enough designed to get best results.



Flow coating—an exclusive action picture. See the fan-like paint jets at rear.

It is an important part of dipping to make sure that products do not float. This can happen if they have air trapped inside them; it causes trouble with the hanger as well as meaning that some areas will not be painted.

With dipping, you find you have low initial cost and very small solvent loss.

Like flow coating it has a big part to play in Canada's industrial future.

The case for flowcoating runs of 200-plus a day

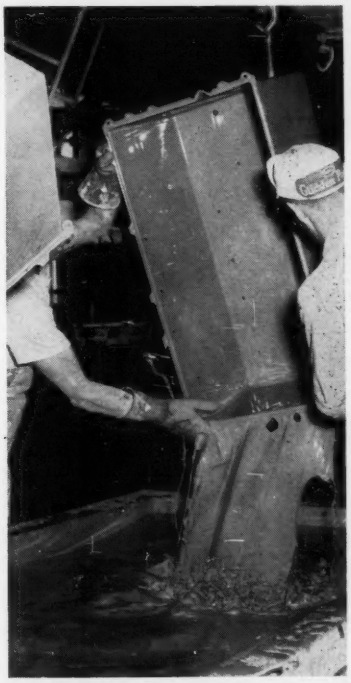
Assumed area to paint by older and new methods, 25,000 sq. ft.

	Older Method*	New Method
Primer thickness	.8 to 1 mil.	.3 to .5 mil.
Coverage per gallon	300 sq. ft.	1,400 sq. ft.
Gallons used	83.33	17.87
Primer cost	$333.32	$107.22
Primer cost per unit	$1.66	$0.535
Enamel thickness	1 mil.	1 mil.
Coverage per gallon	300 sq. ft.	300 sq. ft.
Gallons used	83.33	41.66
Enamel cost	$416.67	$208.33
Enamel cost per unit	$3.74	$1.57½

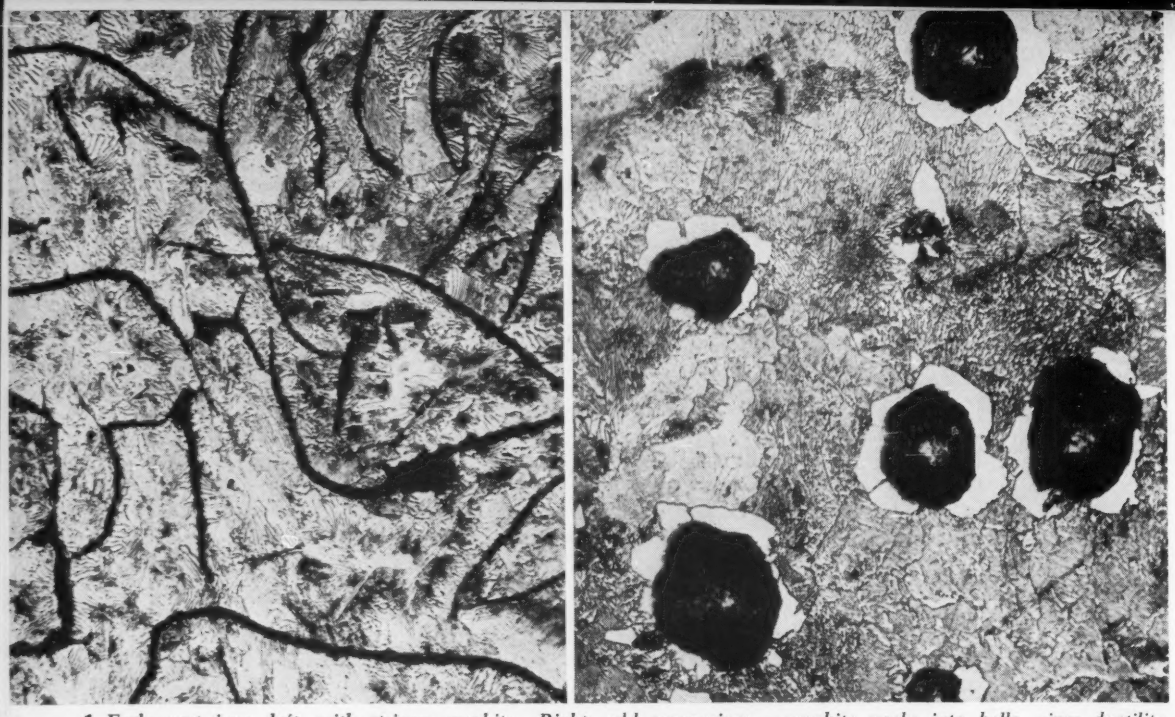
Savings per unit $2.16½

Savings per day $433.00

*Older method is taken as a spray primer and enamel, new method as flowcoated Nu-Pon primer and spray enamel.



Another exclusive picture — a part that might float is dipped by hand.



1 *Early cast iron, left, with stringy graphite. Right, add magnesium — graphite packs into balls, gives ductility.*

This Iron took 2,000 Years to Come

Cast iron's brittleness has been overcome at last. The new ductile is still cheap to cast and use; but it bends.

IT HAS TAKEN about 2,200 years to do something about the brittleness of cast iron. A broken spear was probably a worse calamity in its day than a broken clutch is to us and so this has certainly been a long, tiresome problem.

Now technology has brought us a family of ductile irons. There are seven of them and they are worth knowing. They keep the processing benefits of cast iron but offer designers a number of special advantages which go even beyond the priceless ductility which has been wanted since before the life of Christ.

The seven (commercial) ductile irons are differently composed and have special strengths. Three of them in particular are luring the engineer away from his old friend (and enemy), cast iron.

Type 60-40-15 is one. It was designed for use on navy ships but has many other jobs to do wherever a metal is needed to stand up to shock and extreme cold.

Another, type 100-75-04, has great strength. It will handle 100,000 psi in tension and has a yield strength as high as 75,000.

Then there is the austenitic type. This ductile iron has tremendous heat and corrosion resistance, is non-magnetic and is the most easily welded of all the ductile irons. It is from 18 to 20 percent nickel with smaller amounts of silicon, manganese, phosphorus, chromium and magnesium.

The difference between ordinary gray cast and ductile irons can be shown (PICTURE 1). In the cast iron, graphite is present in the form of random, stringy flakes; these flakes break up the metal matrix and lead to low strength with brittleness.

But add a little magnesium and the pattern alters. The graphite changes from stringy flakes into spheres which give a stronger, tougher metal. And this is ductile iron.

It is not expensive—even in first cost.* Beyond this, are further savings because

The ductile family

60-40-15	Good shock resistance at low temperatures. Performs well on ships for electrical equipment, engine blocks and so on.
60-45-10	Maximum toughness with machinability and weldability. For pressure castings, shock resistance parts for automobiles.
80-60-03	Strongest in its "as-cast" state. Resists wear, machines well. Use for hammer anvils, crankshafts, press side panels.
100-75-04	Combines strength, toughness and wear resistance for use as gears, crankshafts, track shoes and ratchets.
120-90-02	Resists wear well, is difficult to weld. Use for pinions gears, dies, track rollers.
Heat resistant type	Strong resistance to oxidation and growth. Use for grate bars, furnace doors, blast furnace parts and so on.
Austenitic	Good corrosion and heat resistance for pumps, and valves handling corrosives, impellers, chemical equipment.

Where the irons are listed by numbers, the first pair of figures give tensile strength in psi, the second pair yield strength in psi, third pair elongation percentage on 2 in.

*It is about five cents a lb. more than gray cast iron.

ductile iron as a casting can be used instead of dearer forgings (or welded structures) for many products.

At present, five Canadian foundries are licensed to make ductile iron.† Their range goes from very small castings to massive automobile fender dies.

The new iron was put to very good use in a dredge clutch two years ago. The dredge had for long been at work clearing overburden on an iron-ore project in Northwestern Ontario. Then it broke a 10-in. forged steel shaft when the cutter head struck a rock ledge. The damage and downtime were serious, so the owners sent for engineers (from the BLM Automatic Clutch Corporation) to see if a better design could be worked out to stop it happening again.

"Yes," said BLM, "it could." A new clutch was made of ductile iron (PICTURE 2) and installed between a 500-hp electric motor and the speed reducer in-drive to the slicer shaft of the dredge. It was designed to engage solidly in normal dredging work, but to slip instantly at 40 per cent overload. For two years the ductile iron clutch has stood up to the violent punishment that has to be part of dredging work.

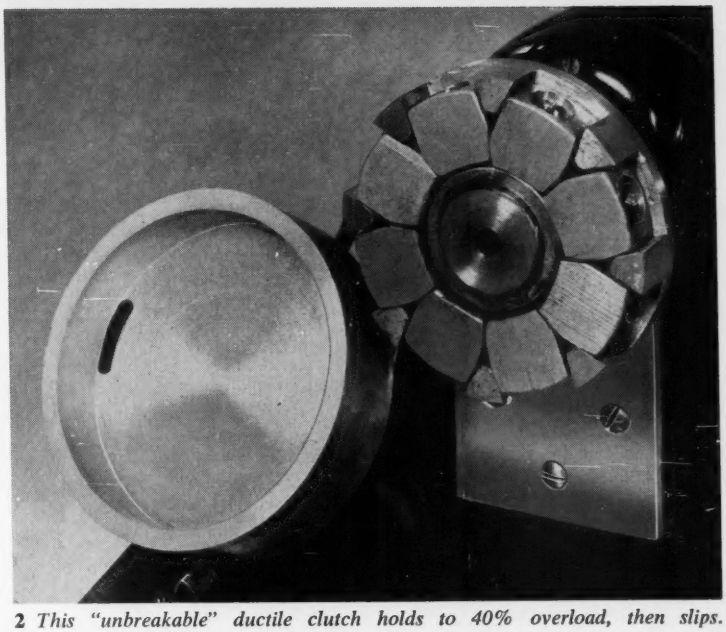
The designers were able to cast the clutch and its outer housing because the ductile iron's high tensile strength would stand up to the rim speed stresses. Without ductile iron, they would have been driven to fabricated or cast steel—and its inflated cost.

Of course there are countless uses for this very modern material. A crankshaft in a high-pressure pump used in the oilfields (PICTURE 3) and a connecting rod and cap (PICTURE 4) are two random examples.

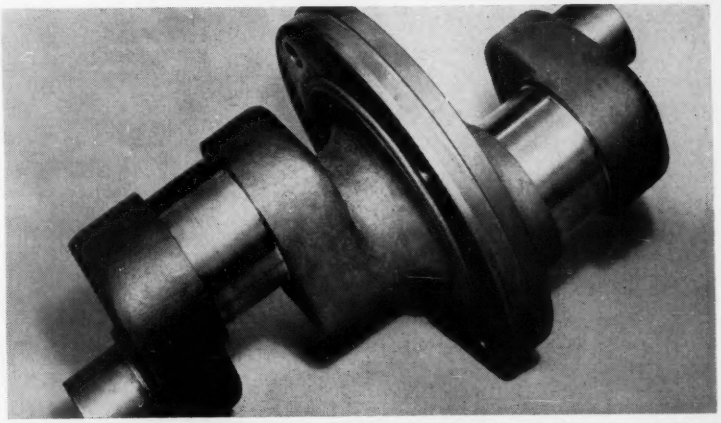
A recent report from the Cooper Bessemer Corporation's foundry in Pennsylvania shows what dramatic results ductile iron can give. The corporation, at work on a navy contract, cast a heavy centre frame for a 1,320-hp diesel engine. In the same heat, they made a two-cylinder section cast in ductile iron; then they attacked it with blows of up to 16,500 ft.-lb. The steel foundation bolts stretched and loosened—but the ductile frame stood fast, unharmed. Who can doubt that this material has a promising future?

It does not, of course, have the same toughness as steel and there will always be cases where shocks are too heavy for it. For these products, cast or wrought steel will still be the right answer.

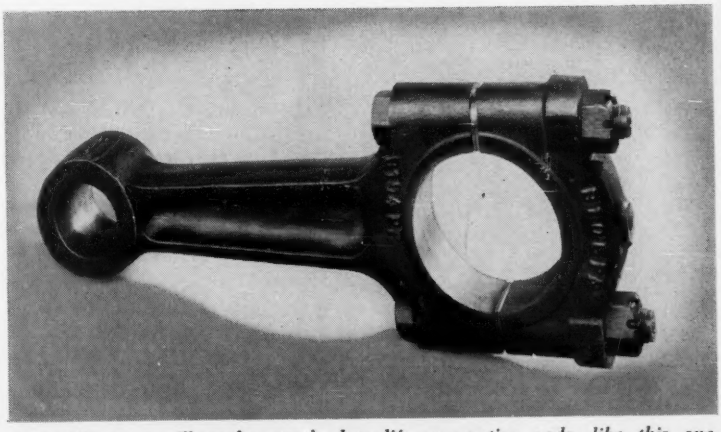
But for many mechanical products, ductile iron is ideal material. Design engineers will be wise to keep it in mind.



2 *This "unbreakable" ductile clutch holds to 40% overload, then slips.*

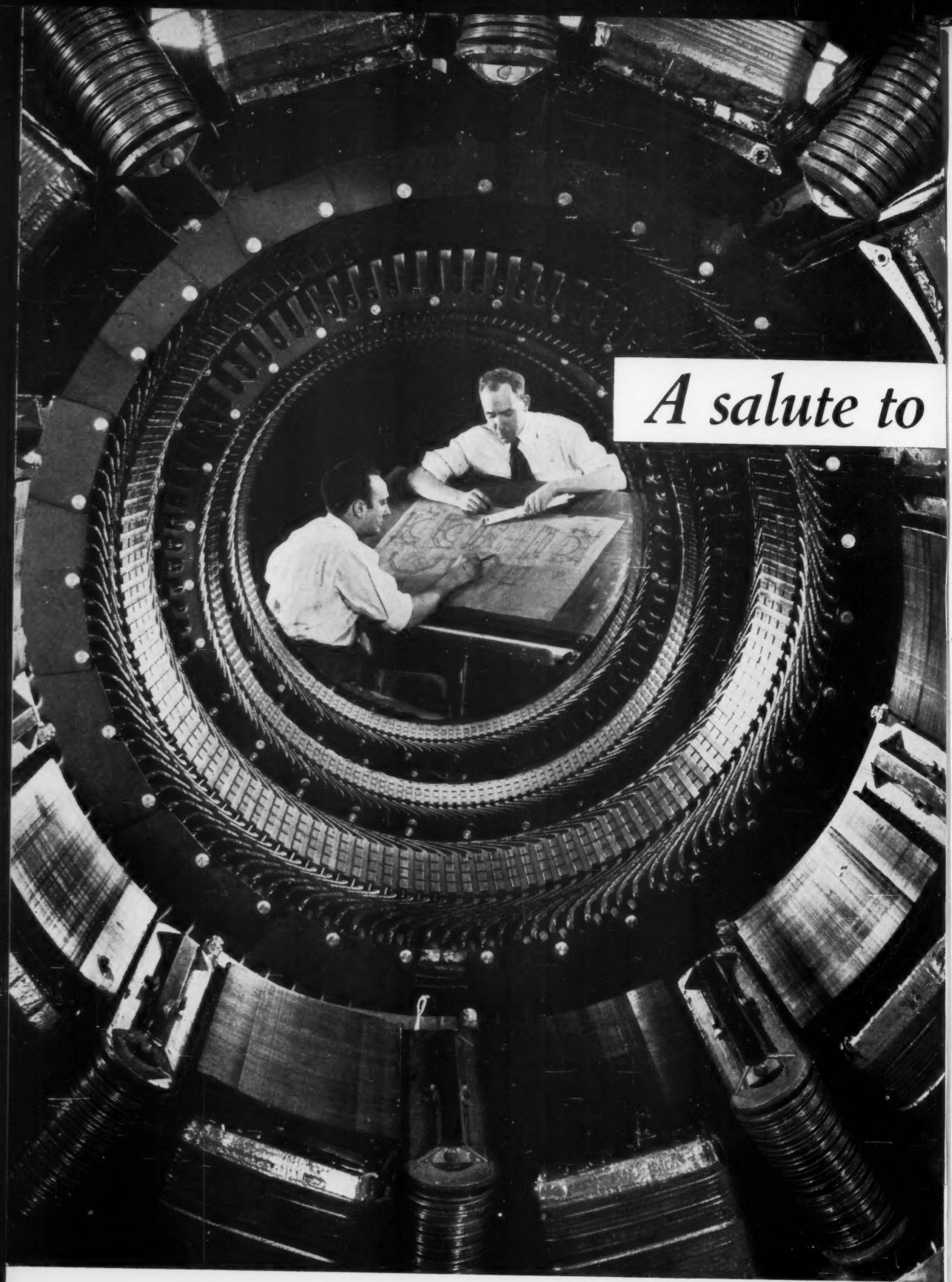


3 *For stresses in high-pressure oilfields pumps, ductile iron crankshafts.*

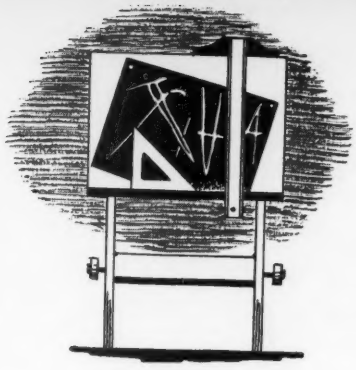


4 *Ductile iron will make sturdy long-life connecting rods, like this one.*

†Bell Foundry Ltd., Winnipeg; Canada Iron Foundries Ltd., Montreal; Dominion Wheel and Foundries Ltd., Toronto; Letson-Burpee Ltd., Vancouver; Otaco Ltd., Orillia, Ont.



CANADIAN GENERAL ELEC



to the design engineer

in every industry . . .

A GENIUS of the 15th Century, Leonardo da Vinci was perhaps the world's first design engineer. His list of designs included the armored tank, the submarine, the helicopter, drainage systems, and many other present-day wonders 500 years before their time.

In the spirit of da Vinci, an ever-increasing group of men and women, down through history, have devoted themselves to designing new uses for new and old resources . . . have made possible the steady progress of civilization.

In every branch of industry in Canada and the world over, design engineers work with the findings of research in creating new products and processes that ultimately benefit all mankind.

Canadian General Electric salutes the design engineers of Canada. Their tireless efforts to improve our products and the processes by which these products are made, have contributed largely to Canada's rapid expansion economically. It has been the privilege of C-G-E engineers, many of them designers in their own right, to work closely with these men in continually improving electrical equipment for Canada's growing industries.

Apparatus Division, 212 King St. West, Toronto

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TRIC COMPANY LIMITED

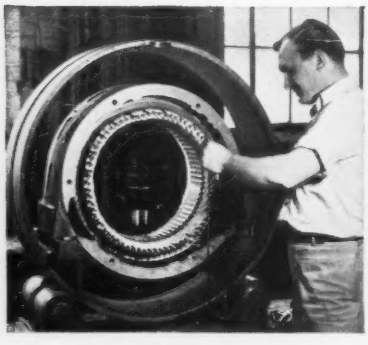
ELISHA OTIS STARTED IT...

Vertical transportation was born in 1853 when Elisha Otis demonstrated his automatic safety device for elevator hoists. He did it by having himself hoisted in it, then ordering the rope to be cut.

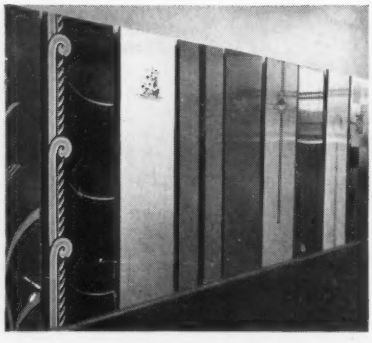
Today, the Otis Elevator Company is a world-wide organization. Its Canadian branch, founded in Hamilton, Ontario, in 1902, boasts a plant over 325,000 square feet in area with some 700 employees.

CILUX HELPS FINISH IT

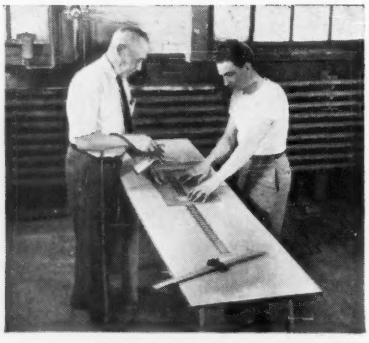
Finishing modern elevators demands a high order of craftsmanship and finishes which consistently meet exacting and often highly specialized requirements. For many years, C-I-L technicians have been consultants and advisers to the Otis Elevator Company Limited in matters pertaining to paint finishing, and most of the materials used are C-I-L products.



Electric coils in modern elevator systems are impregnated with an insulating compound. The casting is painted.



Otis provides a wide range of attractive elevator door designs, many created especially for individual jobs.



Preparing stencils for elevator door panels is precise, exacting work demanding great care and attention to detail.

• • •

For expert advice on your finishing problems, whether they involve costs, performance or tough technical "bugs", call or write your nearest C-I-L Paint and Varnish Division District Office. *Halifax, Montreal, Toronto, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver.*

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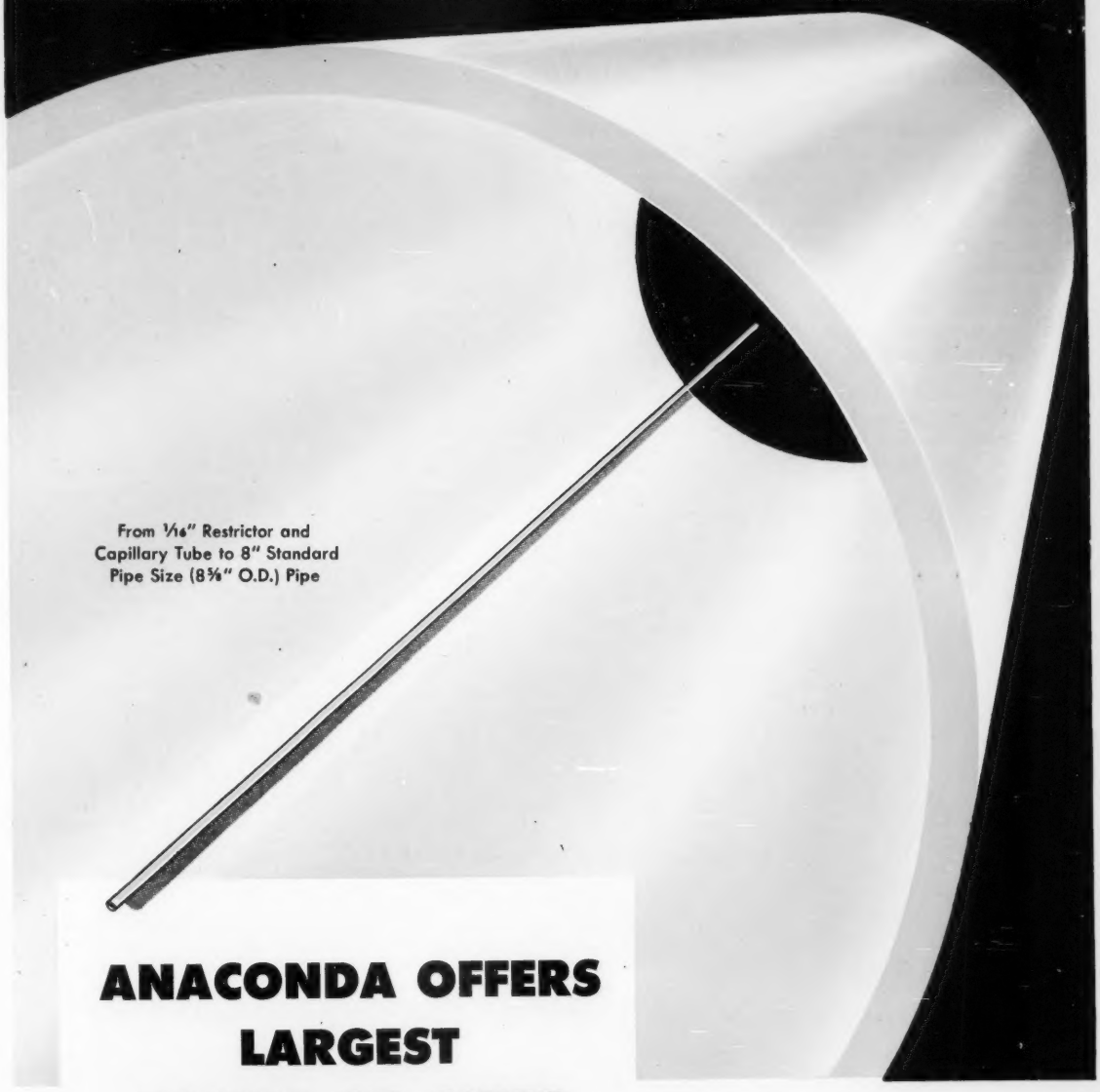

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If you have a metal problem take it first to Anaconda! Anaconda has the facilities to meet most industrial requirements for copper and copper alloy sheet, rod and tube.

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New materials and tools designed for you

SIGHT FLOW INDICATORS of a new type are announced by Jerguson Gage and Valve., Co., for use in new or existing pipe lines.

They can be had in transparent two-window and one-window and Reflex one-window models.

It is claimed that the liquid flow is seen better with this type of indicator because of turbulence through the uninterrupted bore of the fitting. (200)

• • •

AN INTEGRAL PART of the Lester 8 oz. injection molding machine (Modern Tool Works Ltd.,) is the internally-heated cylinder.

This increases the heating contact surface and so helps to plasticize the material and cut down rejects. (201)

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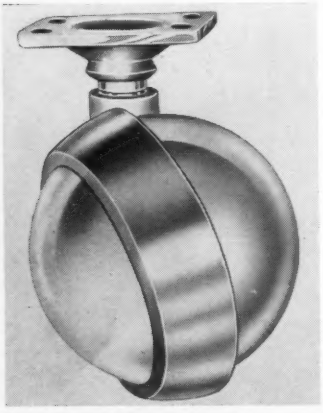


Wheels give way to spheres

THE ORDINARY WHEEL and axle castor may soon belong to the past. A new castor (invented in Australia) using two smooth half-spheres is bidding to take its place. The outer half-sphere rotates on an axle fixed to the inner half-sphere and the inner half-sphere rotates on a vertical pivot.

Big claims are made for the new design. Known as the Shepherd castor, it is said to have an instant swivel action, a 25 per cent reduced rolling drag and to stand up well to hard factory conditions.

The castor is being made by Boileau-Fergusson Limited. (202)

• • •

A NEW DEVELOPMENT in the plastics field is a bearing now being produced in Scotland. It should be suitable for use when there is risk of oil contamination, as in machines for processing food or textiles.

The new bush is of steel lined with bronze impregnated with polytetrafluoroethylene (PTFE), known as Fluon, a plastic developed from fluorine.

The PTFE forms a bearing surface with a low coefficient of friction of 0.04 to do away with a need for lubrication. (203)

• • •

A SOLAR-POWERED experimental radio transmitter, the size of a package of cigarettes, has been built by a General Electric development engineer.

The transmitter is self-contained. It uses transistors instead of batteries. When light rays strike a selenium cell, enough electrical energy is passed to the transistors to work the transmitter.

Transistors are used in the oscillator circuit of the transmitter because they have small power needs and take up less room than tubes.

The transmitter has a short range of about 100 ft. This could be improved by having more selenium solar energy converters or by using silicon or germanium instead of selenium.

A car radio can be used to receive messages broadcast by the transmitter. It will be developed more fully. (204)

• • •

A NEW HIGH SPEED hobbing machine has been produced by the Michigan Tool Company. It gives wholly automatic production of gears to specified limits.

Blanks are loaded into the machine and emerge from it as accurate gears. Tolerances are checked throughout the run automatically by the machine. (205)

CGE Succeeded

WHEN THE RESOURCEFUL (U. S.) General Electric Company reported that plastic casings for indoor transformers were not a success, the Canadian General Electric Company was unconvinced.

It put its Apparatus Division to work and has now come up with the first big change in indoor transformer design in 24 years.

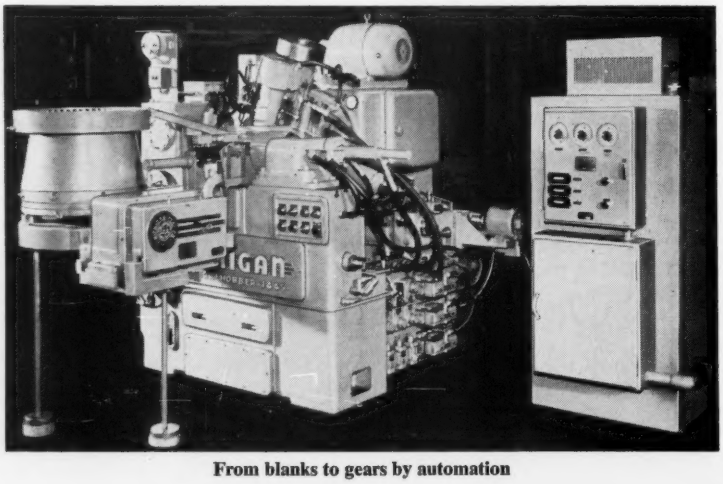
The new PV 3 transformer is cased in epoxy plastic, is tough, shatterproof and 10 per cent cheaper than the old model.

The PV 3 is rated up to 15 kv, 200 volt-amps and can be had in voltages from 6,900 to 13,800, or in the low voltage of 115.

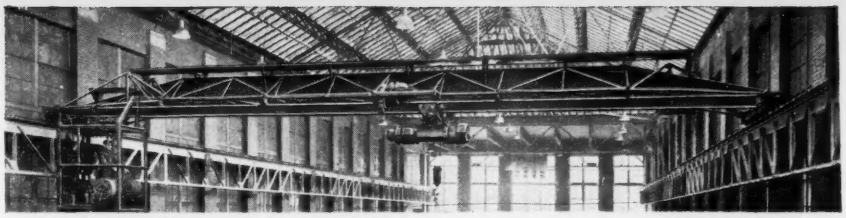
The new transformer which out-performs all official requirements is designed to replace the old steel-cased compound filled types and has been approved by the Trade and Commerce Department. (206)

• • •

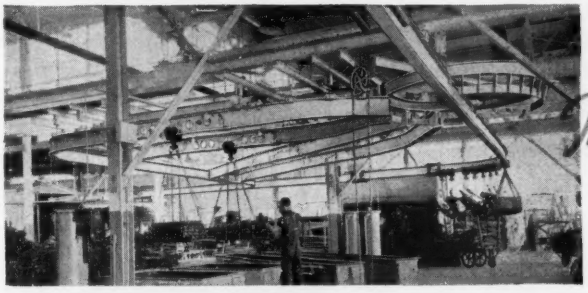
A NEW TYPE of automobile battery regulated simply by turning a key has been put on the market by the Willard Storage Battery Co., of Canada. This turns it from a summer into a winter battery. (207)



From blanks to gears by automation



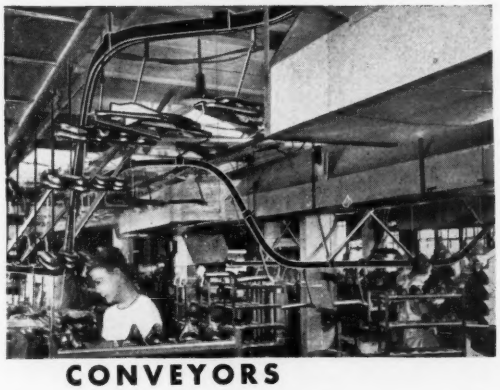
CRANES



MONORAILS

The "BIG 3"

CRANES — MONORAILS CONVEYORS



CONVEYORS

Used separately or in combination — the increase in production and time-saving opportunities for moving materials are too important to overlook.

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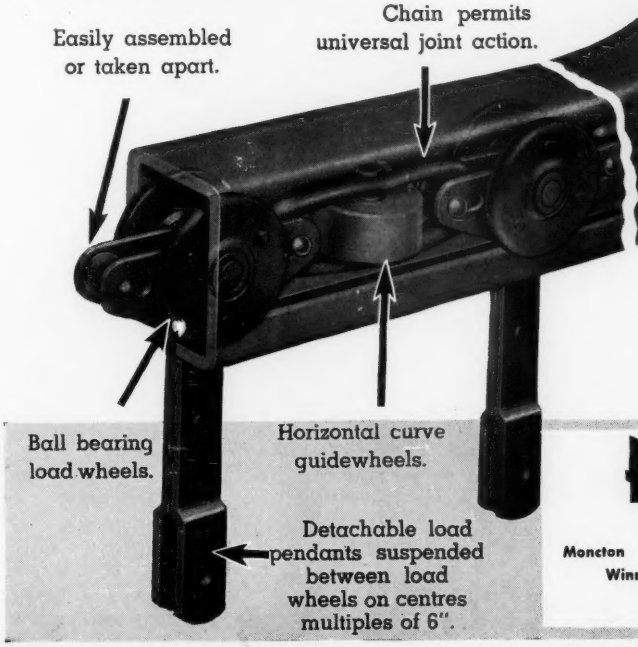
CONTINUOUS ENCASED POWER CONVEYOR
CURVES UP - DOWN - SIDEWAYS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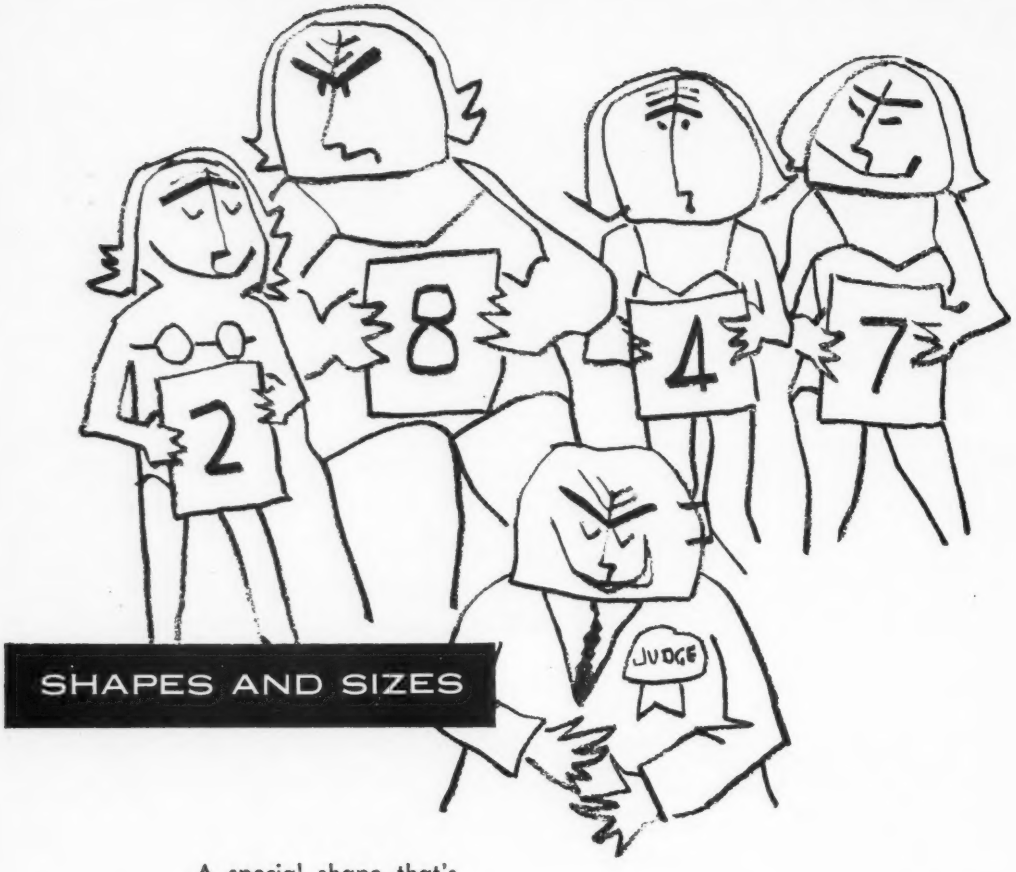

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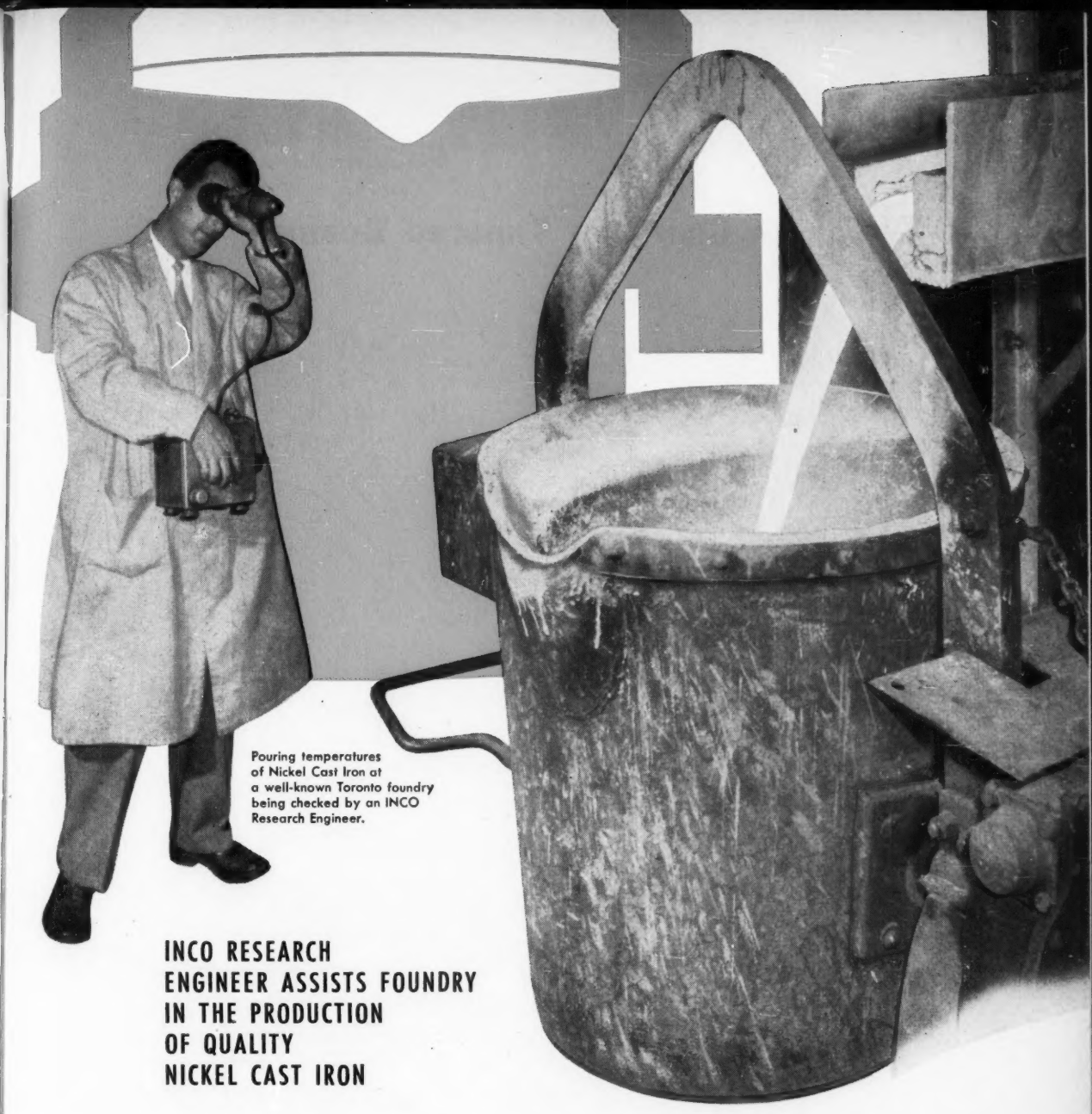

Pouring temperatures of Nickel Cast Iron at a well-known Toronto foundry being checked by an INCO Research Engineer.

INCO RESEARCH ENGINEER ASSISTS FOUNDRY IN THE PRODUCTION OF QUALITY NICKEL CAST IRON

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For years INCO has put its facilities, personnel and experience at the service of industry. Above is an example of the close liaison and assistance on the part of INCO Engineers with industrial users of INCO NICKEL. The wide range of practical experience of INCO Research Engineers, plus the fund of information available to them from the thousands of records on file, provides industry with a unique form of personal service and assistance on metals.

**Information involving corrosion, fabrication, foundry problems, high and low temperature service and metals selection.*

INCO SERVICE GOES WITH INCO NICKEL

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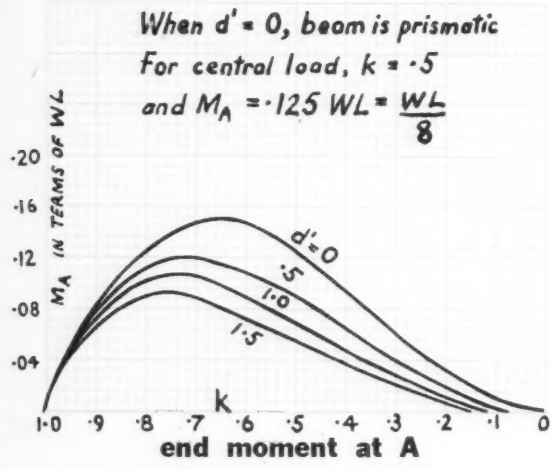
DEVELOPMENT AND RESEARCH DIVISION

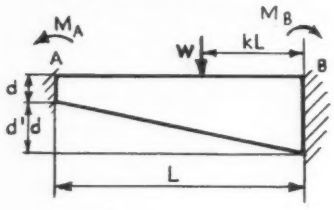
THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED, 25 KING ST. W., TORONTO

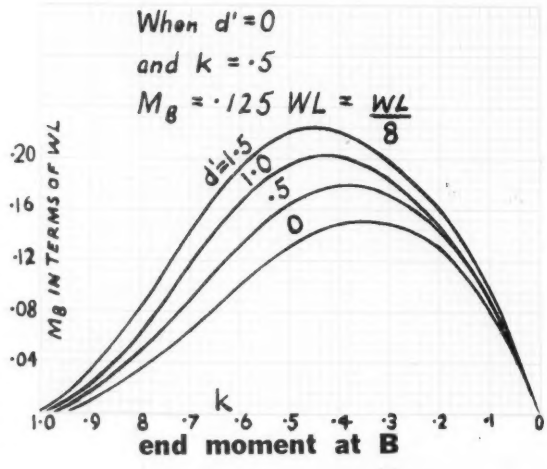
Data Sheet No. 1

Design Chart for Tapered Beams

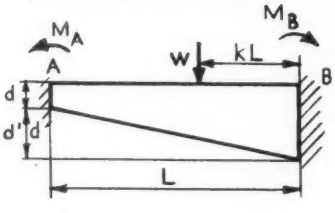


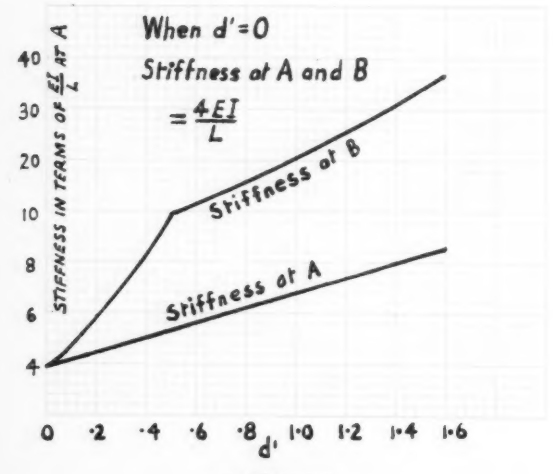
end moment at A



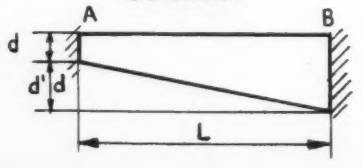


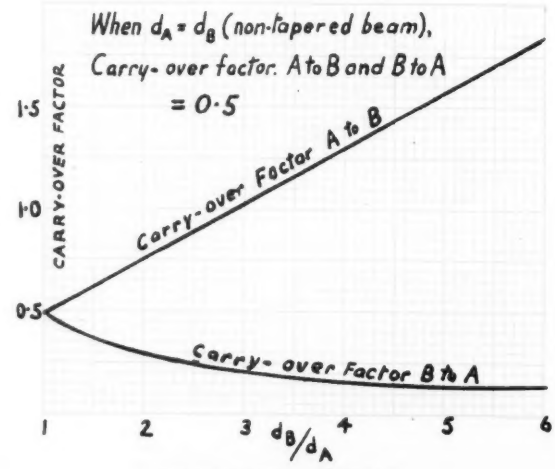
end moment at B





stiffness





carry-over factor

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LYMAN TUBE AND BEARINGS, LIMITED

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Jet Engines

(Continued from page 35)

came good enough. This gave reduced machining and assembly times with both greater strength and less weight.

The compressor rotor is made up of three aluminum drums, two steel shafts and ten bladed discs shrunk on to the drums with spacer rings between their rims. The three-drum design was used so that the end discs could overhang the bearing shafts to reduce bearing distance and to give a more rigid rotor for a given weight. This proved itself to be one of the most stable compressor-rotor designs of its time.

At first it was felt that the disc hubs would have to be accurately positioned (axially) to prevent dishing of the high-stressed webs. Several shims were used to give a tolerance build-up and much assembly time went in choosing the shim thicknesses. Then engine running showed that as long web dishing was not severe, the hubs would find their own positions since the first high interference fit is greatly decreased by centrifugal force when the engine is working.

So, by the simple re-sizing of the drums, discs and spacer rings, the shims went out and assembly was speeded.

Simple flanges would do

The flanges of the drums and shafts began life as the reverse spot-faced buttress type to get rid of stress concentrations from high shaft bending stresses in flight. But laboratory tests showed that so long as they were properly designed, simple flanges would do; and so the reverse spot-facing work was dropped.

Then the bolt holes of the mating flanges were previously line-reamed on assembly and the bolts were chosen for a snug fit. This waste of time has been eliminated. Hole sizes and positions and bolt diameters are under close control and interchangeability has been gained.

There are other ways that production has been streamlined. Each compressor blade of the early engine was hand-fitted in its dovetail support slot. Material had to be taken from the bottom of the dovetail and the tip movement checked. But test experiments showed that the fit tolerances could be stepped up to give proper dimension control of blade roots and disc slots, to do away with hand fitting. Blades are now taken straight from stores and fitted at random into the discs and stator rings—and time is saved.

The centre frame, an aluminum alloy casting, has changed very little during its history. The backbone support bosses and gussets were enlarged to make them stand up better to very high manoeuvre bending forces and to the axial gas load of the combustion chambers. In the early days, 14 bolts clamped the combustion chambers to the frame—using a standard gasket. Then an elastomer designed in the form of O rings was produced which could survive the temperature and make a good seal with only two bolts per flange. The seal was, in fact, improved—and again time was saved.

Recently a magnesium alloy replaced the aluminum to give a stronger structure and a weight saving of 40 lb.

The rear frame (or nozzle box) has changed a little but a number of design improvements have not yet been used. The main bodies of the inner and outer casings (PICTURE 5) were originally machined from rough stainless steel castings. This slowed production and wasted a terrific amount of raw material in the form of swarf. Both these parts are now built of sheet metal and rolled and butt-welded rings. This way, weight was decreased, fewer critical materials were used, cost went down and rigidity up.

If the part were being designed today, the inner and outer casings would be part of a single welded structure to give even more rigidity (with less eccentricity) and so, because it would affect blade-tip clearances, better turbine efficiency. In this case, maximum sea level static thrust can decrease as much as 15 lb. for each .001 in. increase in average turbine blade-tip clearance.

The turbine nozzles are precision castings. They are made of a nickel-cobalt alloy and are individually mounted in supporting slots. This alloy can be machined only by grinding—and a good deal of grinding is necessary to finish the support shrouds to the right tolerances.

The development of high temperature brazing compounds will lead to much better designed turbine nozzles and other "hot-end" assemblies. The nozzles will be simple castings, needing little or no machining, brazed to separate shrouds in groups.

Laid off? And you supposed to be the best production man in town?

The present exhaust cone (PICTURE 6) is made up of a stainless steel outer casing and an inner cone—or bullet. Both are stiffened with spot-welded Z stiffeners and the bullet is supported by two sets of four crosstubes. The forward set is linked by outside pipes which carry cooling air to the rear face of the turbine disc. Mounted on the support tubes, are four streamlined vanes built of folded skins spot-welded to internal ribs.

This construction was used widely eight years ago and is even appearing on some new engines. But it is complex and costly. It also cracks and buckles—especially near the stiffener spot-welds—due to thermal shock and vibration. Engine companies have made many attempts to beat these failures. But usually it has just meant adding extra stiffeners, doubler plates and the like—to overcome the results instead of the causes.

Long life from careful study

Careful study suggests that if the material is allowed to breathe with temperature changes and if spot-welds and locally stiffened areas can be got rid of, life will be prolonged.

When two metal sheets are spot-welded together, their thickness at the periphery of the nugget is reduced by the welding electrodes. Stresses caused in this area by the hot skin and cooler stiffener and by vibration start a crack; in time the crack progresses toward serious failure.

A drawing (PICTURE 7) shows the solution. It is simpler and lighter and has proved itself on the test bed. It will be used in new engines.

The outer casing Z stiffeners were removed. Four sheet-metal pressings (each consisting of one half of two vanes with integral pressed-in stiffening beads and one quarter of the bullet) are welded together. This makes the complete unit. It became clear that internal stiffening plates in the vane root fillet areas would be needed to overcome metal fatigue caused by torsional vibration of the bullet. But these were the only additions made during the development period.

An end plate on each vane has a support sleeve which engages a hollow radial pin connected to the outer casing via a double plate. So, the bullet is rigidly supported and is yet free to expand radially. One of the support pins is connected to the centre of the bullet diaphragm by a tube for carrying turbine cooling air—which gets rid of the outside air manifold.

The new exhaust cone came after intense study of failures. It could not have

(Continued on page 74)

Let a Pulse Search

(Continued from page 39)

recording of data). One other important point is the ability of this test to find discontinuities close to the surface and to test thin materials effectively.

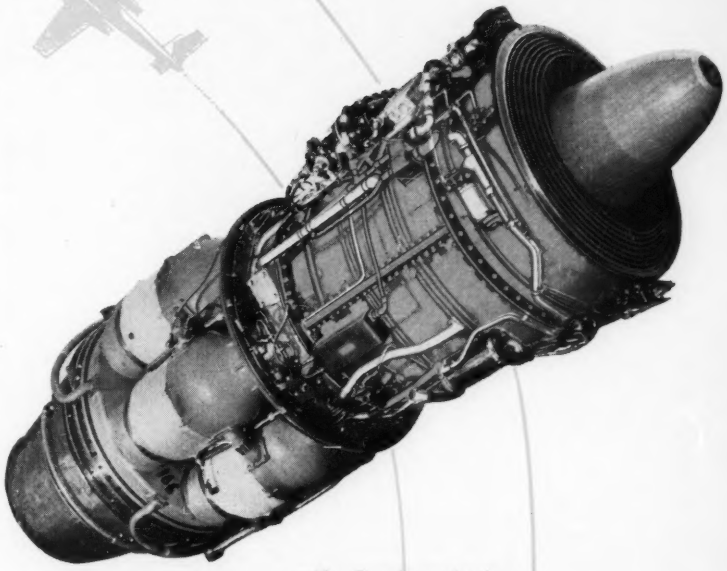
Mention should be made of ultrasonic thickness measuring units which operate on the Resonance Method. The transducer imparts a continuous beam of ultrasonic vibrations into a piece of metal. Resonance will occur when the thickness of the metal is equal to one half the transmitted wave length. The thickness of the metal may then be worked out. Instruments are also available which read thickness directly on a cathode-ray tube. They can be connected to a power line or can be portable models worked by batteries. In these units harmonics are recognized audibly and calculation by a simple formula gives the thickness of the metal.

A good ultrasonic device has been designed by Canadian engineers for the non-destructive testing of concrete. This unit uses the pulse technique with lower frequencies. Ultrasonic vibrations are generated by Rochelle salt crystals and not by quartz and the search units, which are big, are completely sunk in oil. A rubber diaphragm retains the oil in an aluminum casing and bulges out from the oil pressure to make a contact surface. The through-transmission technique is used and the speed of sound in the concrete is measured on a cathode ray tube in micro-seconds. The speed (calculated by formula) shows the quality of the concrete.

One of the most important jobs for ultrasonic inspection (and this applies to other non-destructive testing techniques) is the fixing of standards. In cases where new part is to be tested, cross sectioning and etching are necessary to relate ultrasonic readings to the size and shape of the defect. Records are essential to an effective testing program, together with calibrated test blocks to help identify defects and the best test frequencies. Records should include the type of crystal, size, frequency and machine setting. From this data a set of first-class-design rules can be evolved.

Ultrasonic testing is already important to the design engineer. And it is getting steadily more so. With keener competition, automation of equipment, new fields of science and technology ahead of him, he can design with better confidence when he knows that ultrasonic inspection will maintain the quality he wants. He will be able to design to lower safety factors, save material and so make good products cheaper. Non-destructive testing is coming forward as a factor in design. He should remember it.

MAGNESIUM plays an important and highly successful part in jet engine construction.



.. The Orenda engine is famous throughout the world for its top performance. MAGNESIUM castings are key components of its structural design.

magnesium

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Patents

Some new ideas win protection in Canada

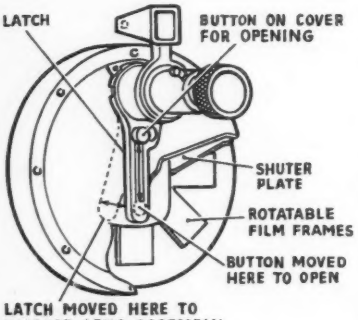
A NEW PROCESS for printing lettering or other markings on inflatable articles like balloons—said to give clear impressions and good registration of different colors—has just been patented in Canada: Patent No. 509,394 dated January 25, 1955.

The process—invented by Arthur L. Smith of La Jolla, California—starts with markings printed on paper with ordinary printing ink.

The paper is covered with a film of rubber: a solution of rubber in a solvent like benzine is run over the printing and allowed to become tacky. The tacky film on the paper is then pressed against the surface of the balloon.

Drying removes the solvent and the paper is soaked off with water—leaving the markings in reverse on the balloon, or other inflatable products. The method is expected to be attractively cheap.

• • •



ACCIDENTAL EXPOSURE of film when the film holder is removed from the camera is prevented by this improved disc-like film holder, patented on January 18, 1955 by American Safety Razor Corporation of Brooklyn, Canadian Patent No. 509,210.

In this type of camera, the film frames are arranged in a circle in the film holder. The holder can be rotated to put each frame in line with an opening in the film holder behind the lens assembly. This opening has a sliding cover to protect the film from light when the lens assembly is removed.

The patented safety feature is the arrangement of the latch and button for freeing the lens assembly: the latch will not free the lens assembly until the button is moved up the slot in the latch as shown in the drawing. That slides the cover over the opening; makes the holder light-tight. This means that the lens assembly cannot be taken off until the film is protected.

The inventors: William E. Tait and August Stellpflug.

The idea of arranging film frames in a disc is not protected by their patent.

• • •

A WARTIME DEVELOPMENT in bearing alloys is now covered by Canadian Patent 509,488 issued January 25 to The International Nickel Company of Canada. The alloy was produced to solve a special wartime problem: galling between moving parts in naval guns. The problem called for a non-magnetic and corrosion-resistant coating on the K-Monel parts.

The answer was a cadmium-silver alloy that could be applied by electroplating or spraying and then remelted for a smooth finish. The inventors were Paul E. Queneau, of Copper Cliff and William A. Mudge, New York.

The patent covers 65% to 95% silver, 5% to 35% cadium, with or without a small proportion of copper and nickel.

• • •

TWO CANADIAN PATENTS relating to amino-formaldehyde resins were issued to American Cyanamid Company on January 18.

Patent No. 509,203 covers rapid curing compositions containing carbamylguanidine salts: freedom from premature curing and good working life are other advantages claimed for these compositions.

The other American Cyanamid Patent, No. 509,202, covers high molecular weight polyhydric alcohols (or their esters) as plasticisers for resins like urea-formaldehyde.

• • •

HIGH IMPACT STRENGTH and resistance to alkali are said to be the advantages of a molding stock now covered by Canadian Patent No. 509,220.

It is an enthanol-soluble product of phenol and acetaldehyde with a fibrous asbestos and hexamethylene tetramine filler.

The patent was issued on January 18 to Canadian Celanese Limited, of Montreal. The inventor: John Allan, of Spondon, England.

• • •

SIMPLER CONTROL for knee-type milling machines is said to be an advantage of an invention protected in Canada by Kearney and Trecker Corporation.

The patent: 509,493 (January 25, 1955); the inventors: Joseph B. Armitage and James N. Flannery.

A feature of this improved spindle transmission control mechanism is a single control handle to position the gears in each of the speed ranges: a rotatable dial linked to the handle indicates the speed of the milling tool.

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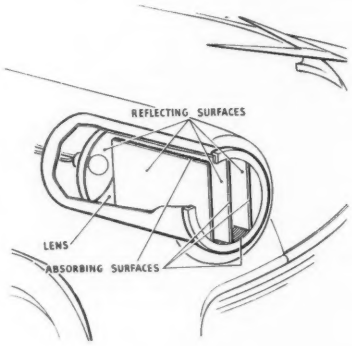

CANADIAN PATENT 509,185 (January 2, 1955) has the answer to headlight glare shown in the drawing above.

Headlights are set in tubes far back in the fenders. Non-reflecting partitions in the tubes screen the lights from oncoming drivers.

The partitions are vertical and run from the front of the headlight tube back to the light. Each has a fluted light absorbing surface on the left side, a reflecting surface on the right side. The inside of each tube has a light-absorbing surface on the right side too.

This gives a narrow beam on the road ahead, with enough spill on the right side to light the shoulder but no glare on the left.

The inventor: William Ramminger.

• • •

ON FEBRUARY 15, two methods for finishing metals by chemical action were patented in Canada.

The blackening process is covered by Patent 510,081; the chemicals are sodium hydroxide and a sodium salt of benzene or toluene sulphone monochloramide in water, and the metal is held in the heated solution until blackened.

This patent issued to the inventor, Isaac L. Newell.

Patent 510,138 claims the aluminum treatment; the metal is immersed in a dilute caustic soda bath that also contains a polishing agent (which may be sodium gluconate), and an oxidizing agent like sodium nitrate.

The patent was issued to The Diversey Corporation (Canada) Limited.

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An automatic bonding material of adjustable density which can be foamed in place to fill any cavity regardless of configuration.

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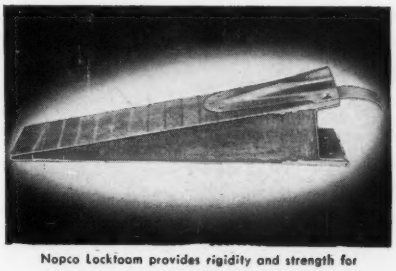
As a strong, lightweight reinforcing material it has won immediate acclaim in the aircraft industry.

In addition to its unique ability to be foamed in place with exceptional ease and speed without the need for complicated equipment, Nopco Lockfoam possesses so many other interesting properties that it has proved ideal for countless applications.

Nopco Lockfoam can be foamed in place to fill any cavity regardless of configuration. Density of the material can be adjusted to meet design requirements. Bonding is automatic. Radar transmission characteristics are excellent. It can be used for electrical and thermal insulation. In its flexible forms, it is capable of absorbing heavy impact loads with low shock transmission. Physical and chemical properties may be varied but are predictable and reproducible. Lockfoam can also be cast in molds, fabricated in both rigid and flexible forms.

The assistance of a technical service staff in the selection, formulation, and application of Lockfoam is available from Nopco's Lockfoam Division. Send for complete technical data.

Lockfoam is a registered trademark of Lockheed Aircraft Corporation



Nopco Lockfoam provides rigidity and strength for plane ailerons. Note cellular structure of rigid Lockfoam thermosetting foamed-in-place plastic.

Nopco Lockfoam is now used by the aircraft industry for a wide variety of applications to:

INCREASE RIGIDITY OF CONTROL SURFACES by filling cavities in ailerons, rudders, elevators, wing tabs

PROVIDE A STRONG CORE sandwiched between Fiberglas skins for nose radomes

STRENGTHEN SHOCK-ABSORBING STRUCTURES

INSULATE cabin ventilating systems

STIFFEN rocket doors to prevent buckling

FABRICATE SHOCK PANELING

DAMPEN VIBRATIONS

POT ELECTRONIC EQUIPMENT

FABRICATE COWLINGS

Nopco Lockfoam has many other potential industrial uses.

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Quotes

Points from current papers and speeches

GEAR TEETH STRESSES and deflections were explored by two experts for ASME members at a recent New York meeting. Joint-authors **Joseph Marin** and **R. H. Shenk** gave a paper which probed the problems of eccentrically loaded gear teeth.

The Lewis formula is accurate enough for finding the stress and deflection in normal gear teeth, said the paper, but for special teeth and for those loaded eccentrically, it is not suitable.

The paper gave a stress analysis of short gear teeth, eccentrically loaded, under the combined effect of bending, torsion, transverse shear, axial compression and stress concentration. The method is based on the so-called distortion energy or Von Mises-Hencky theory of failure.

An analysis of the deflection in short, eccentrically loaded gear teeth due to bending, torsion and transverse shear was also put forward.

The paper showed that results by the usual approximate method are in some cases quite different from those given by this more exact method.

• • •

WHEN AN ALLISON designer spoke to ASME members about the design problems in gas turbine engines, he mentioned jet complexity as one reason why stress analysis was difficult. In doing so, **P. N. Bright** showed the U. S. to be in tune with Canadian turbo-thoughts (the Orenda story, page 23).

Other difficulties he listed as the fact that the field is new, loads are not exactly known and designers must work to very close limits.

The paper confined itself to some of the problems that have been met and overcome in Allison engines and mentioned where more accurate design is needed and what is being done about it.

Only static and dynamic loads were discussed: the effect of vibration, critical frequencies and so on was not included.

• • •

IN A LECTURE given at the SAE Golden Anniversary meeting in March, **Robert H. Barbour** and **Robert O. Isenbarger** defined a fluid or hydraulic seal as a device to prevent the escape of fluids between two parts of a mechanism.

Very little data exists on the subject and the recent strides made in machine design make increased research on seals and materials very necessary and urgent.

Although the main operating conditions of a seal, such as temperature, pressure, speed and so on are known, some of the minor conditions affecting function may be more indeterminate.

To decide on the type of seal to use the design engineer must know all the conditions, major and minor, and have before him a drawing of the installation, showing how the mechanism operates.

There is no single material ideal for all seals; a material may be suitable for some uses and unsuitable for others. For instance, a seal having good temperature flexibility does not usually have good oil resistance, so if these conditions occur at the same time the design can only be a compromise.

One very important question is can the part be molded or formed economically? A design would be of little value if it could not.

Engineers who are designing with elastomeric materials must make allowance for plastic flow and also for their high coefficient of friction when not lubricated.

Developments in fluid seals over the past years have enabled the design engineer to use such things as automatic transmissions, power steering, automatic window lifts and the like.

• • •

AN ACROSS-THE-BOARD look at plastics for truck bodies has been given by plastics expert **H. McCann** at an SAE Symposium. He dealt mainly with thermoset materials, the polyesters and epoxies.

In simple resin form these are rather brittle but when reinforced with glass and filled with some inorganic material, large and complicated shapes can be molded.

They can be catalyzed to produce a cure, so that outside heat is not necessary when molding. As a result, they can be molded with reinforcement at very low pressures. They have high inherent corrosion resistance, are basic thermal and electrical insulated, have a relatively high strength—weight ratio, are colorable in both opaque and transculent form, are bondable with proper adhesives and take a good finish in the mold or can be painted after molding.

The polyesters are lower in cost than the epoxies and the technology of the polyesters reinforced with fibrous glass is better known.

They are composite materials literally created on the job and the manufacturer is thus faced with human, mechanical and chemical uncertainty in every stage. Present-day chemistry is probably 10 years ahead of mechanical engineering in this field. Greater flame resistance of chemical adhesives is required. A better understanding is needed on the part of the design engineer because a change in design creates a new engineering problem, both chemical and mechanical.

• • •

THE DESIGN of the expanding shoe friction clutch was discussed by **Dr. M. J. Cohen** at an ASME meeting.

He described a complete and exact treatment of the problem. His method took account of the dimensions, elastic properties and the forces and moments and sets up three basic equations of equilibrium.

A simple, quick and reliable method for designing a clutch to transmit a given torque result.

• • •

THE DEVELOPMENT of a new gas turbine super alloy GMR-235 was the subject of a recent SAE paper by **D. Hanink, F. J. Webbere** and **A. L. Boegehold** of the Research Laboratories Division, General Motors Corporation.

More than 500 tons of the alloy have been used in gas turbines and 12 sets of buckets have run for more than 500 hrs., without a single bucket failure.

This new casting material has basically about 60% nickel with maximum percentage additions of chromium (17), aluminum (3.5), titanium (2.5) and boron (0.10). The aluminum and titanium act as hardeners whilst the boron improves the high temperature strength and ductility.

Curves are given in the report showing the tensile properties of GMR-235 at temperatures up to 1,700 F, the effect of boron content on stress-rupture properties and of heat treatment on its physical properties. Thermal shock and fatigue at elevated temperature are next discussed. Information is also given on heat treatment and foundry techniques.

• • •

THE PURPOSE OF an SAE paper by **W. J. Simpson** was to focus attention on a few of the more recent synthetic elastomeric materials and also to show that some of the older types of synthetic polymer are now so improved as to have new uses.

With this in view, the paper has sections on Buna S and N, Butyl, Neoprene, Silicone rubber, Vinyl and Isocyanate foamed rubbers. Reasons for and against each type are listed in a series of useful tables. Future elastomers may so improve, that they will be used where synthetic rubber is out of the question.

DOW CORNING *first in* SILICONES

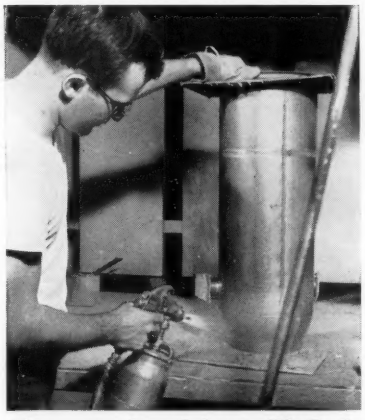
Silicone News

FOR DESIGN ENGINEERS No. 13

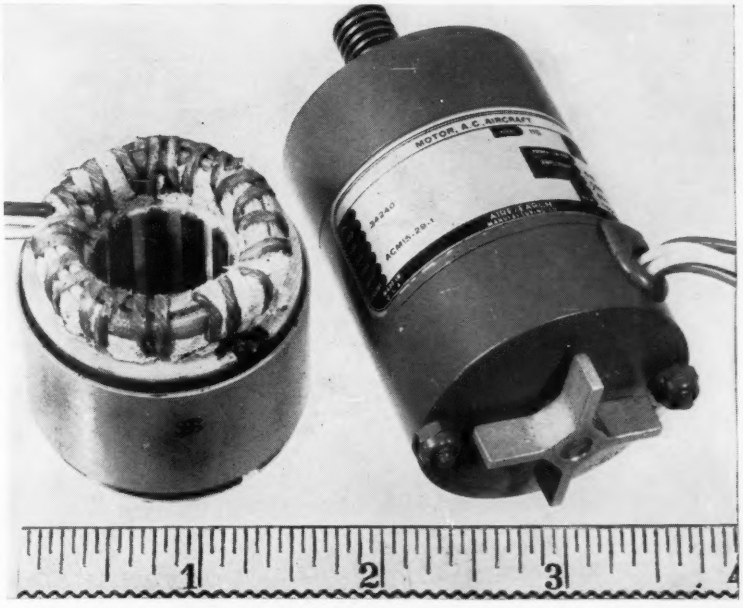
Silicone Aluminum Paint Protects Jet Engine Combustion Chambers

The materials used in many of the combustion chambers and burner supports manufactured for J-35 jet engines by Solar Aircraft of Des Moines, must remain unaffected by abnormally high temperatures. Aluminum clad steel solves the problem satisfactorily with exception of various fusion welds. These must be recoated with aluminum or a noncorrosive coating that will withstand up to 800 F.

Solar engineers have the answer to that problem, too. They simply spray or dip the welded part with two coats of Sicon, an aluminum paint formulated with Dow Corning silicone resins by Midland Industrial Finishes.



After a one hour bake at 400 F, the silicone based coating provides the required protection. According to Solar, this is one of the most satisfactory paints for use on jet engine parts. *No. 127*



SILICONE INSULATION ADDS LIFE, CUTS SIZE OF MINIATURE MOTOR IN B-52A BOMBER

PROBLEM:

Ambient temperatures range from —65 to 300 F.

Size and weight must be held to a minimum.

Maximum reliability is imperative.

To meet those requirements, design a miniature a-c motor for continuous duty in the oil temperature controller for the Boeing B-52A Stratofortress.

SOLUTION:

Design engineers with the AiResearch Manufacturing Division of The Garret Corporation found the best solution to that problem in electrical insulating materials and high temperature paints made with Dow Corning silicones. Dow Corning 33 Grease solved the bearing problem.

A silicone bonded asbestos-glass laminate, made by the Irvington Varnish and Insulator Company is used for slot and phase insulation. Dow Corning Sylkyd enameled magnet wire, manufactured by Hi-Temp Wires, Inc. is used in the windings. Silicone-glass laminate is used for end laminations and slot wedges. End connections are tied with Silastic-impregnated glass cord.

Silastic-impregnated Turbo 117 glass sleeving, made by William Brand and Company, is used to insulate the connections because of its flexibility and outstanding resistance to fraying.

(Cont. pg. 2)

SILICONES IMPROVE LICENSE PLATE APPEARANCE AND SERVICE LIFE

Next time you see one of the 4,000,000 vehicles bearing the white on green 1955 Michigan license plate, note the smoothness and gloss of the green background. That's because the paint, supplied by the Saginaw Paint Company of Saginaw, Michigan, was formulated with Dow Corning 200 Fluid. Addition of less than 1% of the silicone fluid helped reduce sags and wrinkles during dipping and increased color retention and resistance to weathering and snow removal chemicals. *No. 128*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING first in SILICONES

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . .

New 1955 Reference Guide to Dow Corning silicone products gives in 8 pages a brief but comprehensive summary of the properties and applications for the silicone products that are most widely used. Products are indexed by type of application. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design, production and maintenance engineers. *No. 132*

Silicone Foaming Powders produce heat-stable, nonflammable, easily machined, low density foam structures for electrical and thermal insulation. Supplied ready to use, they can be foamed in place and often cured in service. Recently published data sheet gives applications, properties and foaming characteristics. *No. 133*

Dow Corning R-4010 Resin is a silicone water repellent coating that markedly improves wet insulation resistance of Class A or Class B electrical equipment. Easily applied by dipping, spraying or brushing, it air dries tack-free in 20 to 30 minutes and cures within 24 hours. *No. 134*

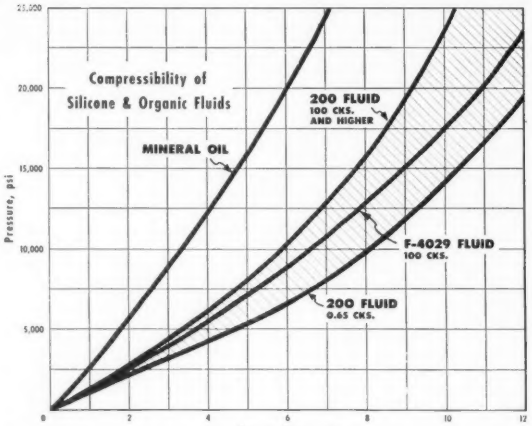
"New Developments in Silicones" is a 16 page progress report which appeared in a recent issue of MACHINE DESIGN. A complete review of the silicone products most useful to designers, the article provides data and illustrates applications for silicone foams, protective coatings, rigid laminates, dielectrics, lubricants, rubber and adhesives. Reprints available. *No. 135*

Dow Corning 36 Emulsion is a completely new silicone mold lubricant. Much more stable than any comparable silicone emulsion, it gives molded parts a superior surface finish. Its stability is attributable to an average particle size of less than 0.5 microns. At concentrations in the range of 1 part emulsion to 100-200 parts water, Dow Corning 36 Emulsion gives clean, easy release of rubber or plastic moldings and cast metal parts. *No. 136*

DESIGNERS USE SILICONE FLUIDS FOR MORE EFFICIENT SPRINGING

Dow Corning silicone fluids have always been noted for their thermal stability and their remarkably flat viscosity-temperature slopes. They have, therefore, been widely used as damping media in such devices as dashpots, overload relays and torsional vibration dampers for crankshafts.

More recently, designers have found that certain silicone fluids, Dow Corning F-4029 and some Dow Corning 200 Fluids, also have high compressibility. Using these fluids, engineers have produced liquid springs and shock absorbers with the same capacity as much larger and heavier metal coil springs. Testing indicates these highly compact liquid springs retain a high order of efficiency even under constant recycling at milli-second intervals.



As shown in the graph, both Dow Corning F-4029 and the Dow Corning 200 Fluids are more compresible than the mineral oil commonly used in liquid springs. At 20,000 psi, F-4029 has a compressibility of 10.8% which is mid-way between that of Dow Corning 200 Fluids of the same and of lower viscosity grades. While it lacks the compressibility of the lower viscosity 200 Fluids, Dow Corning F-4029 is less volatile and has a lower viscosity-temperature coefficient. *No. 130*

Westinghouse Seals New Switches With Silastic for Sub-zero Service

Sealed, top and bottom, with Silastic gaskets, the new Westinghouse gas-filled, load interrupter switches remain operable at temperatures as low as —65 F. Organic rubber seals were originally tried, but sub-zero weather caused the seals to harden and shrink, allowing the sulfur hexafluoride gas to escape.

On testing, Westinghouse engineers found that Silastic gaskets easily passed all pressure, vacuum, and temperature requirements, and were not affected by the gas. The Silastic gaskets provide such a tight seal that Westinghouse expects the units to hold gas pressures of 30 psi indefinitely without recharging. *No. 131*

MINIATURE MOTORS *(Continued)*

The stator is impregnated with Dow Corning 997 silicone varnish and baked at 400 F. The stator bore is painted with Sicon black silicone enamel, manufactured by Midland Industrial Finishes.

The ball bearings are lubricated with Dow Corning 33 silicone grease to give long service at temperatures ranging from —65 to 300 F. *No. 129*

Dow Corning Silicones Ltd. Toronto, Ontario

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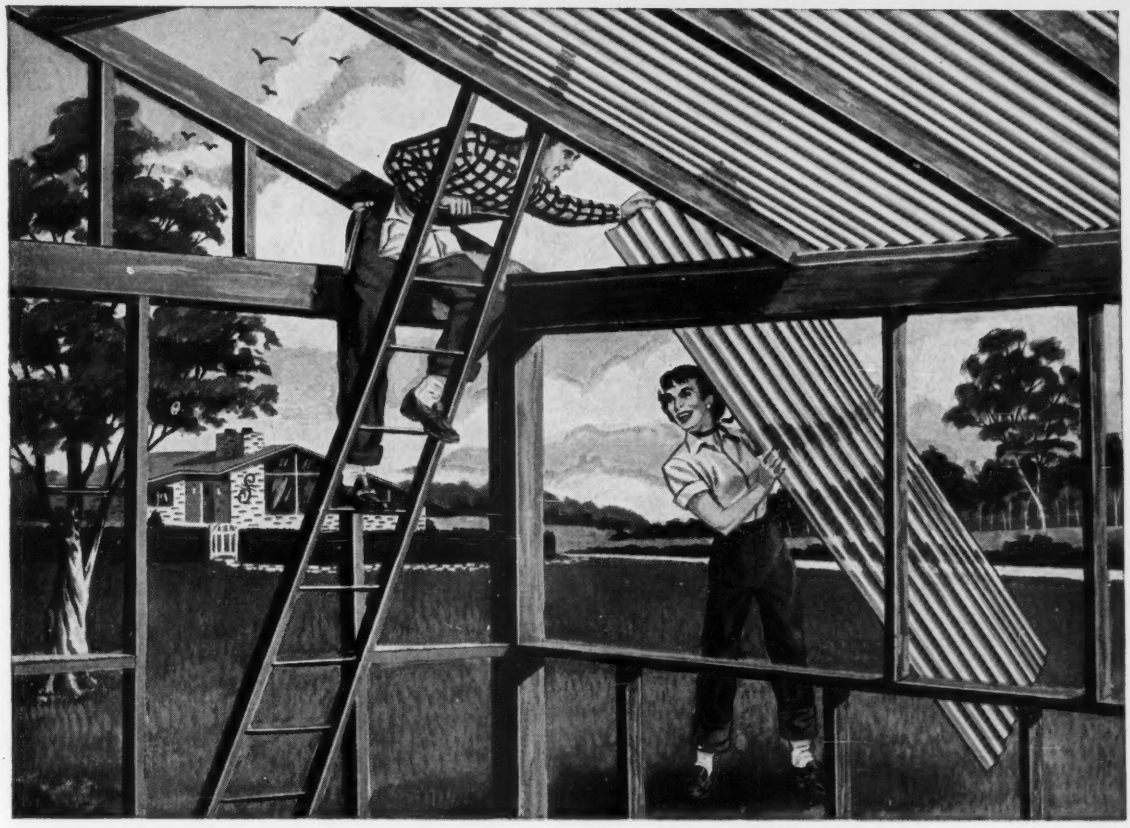

Up comes a bright new idea — with Vibrin

ONE OF THE BRIGHTEST new ideas in the building and decorating fields is the colorful translucent sheeting shown here as a patio roof. Shatterproof, permanent, and extremely light, it is unaffected by moisture, mildew, heat or cold. It is easily nailed, sawed, screwed, or bolted to make everything from shower stalls to garden walls, from factory skylights to store fronts.

Back of this new sheeting — and many other dramatic developments — is Vibrin polyester resin, made in Canada by Naugatuck Chemicals. Vibrin properties are remarkable. Reinforced with glass fibres — as in sheeting — it is many times stronger than steel on a weight basis. It has excellent structural qualities, and will not dent, sag, craze, warp or rust. It is resistant to most acids and alkalis.

Vibrin is extremely easy to form, requiring little or no pressure or heat. Tools and molds are inexpensive. Short runs are economical and profitable.

Applications for Vibrin are almost limitless. Besides sheeting, they include boat hulls, fishing rods, insulators, machine housings, luggage, aircraft parts, and chemical piping. Vibrin is constantly improving present products, giving reality to new ideas, and cutting manufacturing costs — *even for those with no previous experience in plastics.* For full details, call or write Naugatuck Chemicals, Elmira, Ontario, or branches shown below.

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Jet Engines

(Continued from page 66)

been evolved without hard experience of the original unit. Now it is a good example of that elusive goal—design simplicity.

Design simplicity is a philosophy. Future turbo-jet generations are going to be more than ever concerned with it, as performance demands go up and up. It took 50 years for aircraft to reach the sonic range—and then what happened? At once, the target became twice the speed of sound.

The trend to higher speeds and altitudes makes harsh demands on engines. Higher thrusts, small increases in frontal area and weight, an ability to work well from take off to transonic speeds at ground level, to climb high into cold, thin altitudes and supersonic flight—all this is now being asked for. What will designers do to keep up?

To get higher thrust, a bigger air swallow will be needed. If this is to be done without adding much to weight and frontal area it will take a very low hub-to-tip ratio at the inlet of the engine; and this will lead to long front-compressor blading—and a new vibration problem.

Vibration fatigue in blades is an exasperating riddle; the causes can be so many but, until the engine is running, are very hard to trace. Even test bed running hardly tells the whole story; it takes flight testing as a rule before a fatigue-free blade can be designed.

Experiments aimed at beating fatigue are now going on. Glass-reinforced plastic blades are being used instead of magnesium and have shown up well in test compressors. The material has about the same density as magnesium and (at temperatures up to 250 deg. C) has high tensile strength. So, very light rotors could be on the way; but the biggest gain will come from the high internal damping quality of the material —and so its strong resistance to fatigue. In fact, tests have shown this material to be nearly incapable of fatigue failure. Probably its temperature limit will be pushed up to about 375 degrees—and the new material will have arrived. It may even be used for discs and compressor casings.

As aircraft speeds increase into the supersonic, so the ram temperature goes up. An aircraft going twice the speed of sound at 30,000 ft. takes in its air at a temperature 180 deg. C—a normal oven baking temperature. And this is the coolest air available in the aircraft. This high temperature will bring the magnesium and aluminum alloys nearer the inlet and, in the centre of the engine, titanium may be used.

Titanium is costly

Titanium is already available as sheet, bar and forgings; but so far it can only be cast in a vacuum and is very expensive —costing $15 to $20 per lb. The early machining difficulties have been beaten and it can be worked now as readily as stainless steel.

The high strength alloys (the ones that could be used for compressor blading and discs) cannot be welded, but the lower strength titanium and a few alloys can be welded in an inert atmosphere. There are difficulties with titanium while it is molten. It attracts nitrogen and oxygen in this state and these cause brittle alloys to form. So, great care has to be taken to make sure the metal is not in contact with air during any melting process.

But despite cost and handling difficulties, titanium is going to be an important material for aero-engines in the near future. It has by far the highest strength to weight ratio of any engineering material and up to about 450 deg. C, is very good at resisting corrosion.

New, cheaper methods for refining titanium have reached the pilot plant stage and as production goes up the cost will come down.

The high strength (at medium temperature) aluminum and magnesium alloys are not weldable and so are used in engines mostly as castings. As they move toward the front of the engine, steel or titanium parts will take their places as welded or brazed structures by sheet, bar, forgings and small castings.

These materials will allow thinner sections to be used with the same rigidity. And since this will lead to more rolling than casting, the sheet metal engine, as it may be called, is certainly the engine of the future.

One way to get more thrust from the same size and weight of power plant, is to increase combustion temperatures. Of course, this will mean higher temperatures for all parts near the gas passage such as discs, blades, nozzles, shrouds and their supporting structures. New alloys are coming along now which will take greater heat than present ones but this is not going to be the whole story. They will hardly carry us into the realm of future turbo-jet combustion temperatures and probably air or liquid cooled turbine blades and nozzles will be seen soon. Cooling methods have already been developed and tested by

(Continued on page 80)

Isocyanates I Q?

(Continued from page 47)

belt coatings, gaskets, and sole and heel materials for military boots.

The isocyanates were developed originally by Farbenfabriken Bayer A.G. of Leverkusen, Germany, during the Second World War. During the latter stages of the war, several test fighter planes were built with foamed-in-place isocyanate in the wings. The foam reduced the weight of inner framework needed, and as a result the final wing was lighter. The wings could be badly shot-up without crippling loss of strength, and the plane did not sink if it crashed into the sea.

Since the war, production has gone ahead quickly in Germany. Many amazing products have been developed. Today almost all magnet wire going into motors, transformers, and field winding is coated with isocyanates. Ultra-tough finishes over wood, which do not chip or crack under blows which dent the substrate, are widely used inside railroad freight cars. Chemically resistant isocyanate coatings are used widely in breweries, dairies, slaughter houses, and as linings for tanker cargo holds. Truck bodies, using an isocyanate foam aluminum sandwich construction, are already in use. These affect valuable earnings by being able to carry greater payloads because of reduced weight.

Progress in United States was slow until early 1954. Then the great importance of these resins was recognized. As a result, millions are now being spent in the building of production plant and equipment. While some firms are now in limited operation, it will be about a year before large quantites can be got from American sources.

The big rubber companies are actively interested in isocyanates and one has an isocyanate synthetic rubber already in production.

The intense interest and large investment made by some big names in the United States chemical industry point to a clear conclusion. Isocyanates are destined to become important commodities.

They will change many of our methods. And a high isocyanate I.Q. will soon be an engineering necessity. Designing tomorrow without knowing isocyanates will be something like designing today with no knowledge of rivets.

Engineering Events

April

6 ASME machine design conference. In New York.

18-21 SAE golden anniversary. Aeronautic meeting and aircraft engineering display. In New York.

18-22 ASME diamond jubilee spring meeting. In Baltimore.

22 SAE branch meeting. Sealed beam headlights. In Windsor.

May

11-13 EIC annual meeting. In Toronto.

11-13 IES annual conference of lighting engineers. In Montreal.

19-20 CAI annual meeting. In Toronto.

23-26 Annual office machinery and equipment exposition. In Toronto.

30- Annual trade fair. In Toronto.

June

7-10 American Welding Society's spring meeting and show. In Kansas City.

-10 Annual trade fair and air show. In Toronto.

16-18 ASME applied mechanics conference. In Troy, New York.

21-24 International aeronautical conference (the fifth). In Los Angeles.

30- SPI Centennial celebration. In London (Ont.).

Quiz Panel

Do you know what these are?

1 Polymethylmethacrylate

2 Anechoic

3 Tchebitcheff's method

4 CSVP and RSVP

5 Stoichiometry

Answers are given below

1 Polymethylmethacrylate: A transparent plastic from ethyl alcohol, sometimes described as organic glass.

2 Anechoic: Echoless. For an accurate comparison of two sound sources, sound reflections must be eradicated. Acoustic measurements would, for instance, be made in an "anechoic" room.

3 Tchebitcheff's method: This is used for finding an area under a curve. Ordinates a, b, c, d, e and f at six predetermined stations are measured, the area under the curve then being $\frac{L}{6}(a+b+c+d+e+f)$ where L is the length of the curve, measured along the base line.

4 CSVP: Constant speed variable pitch. RSVP: Remember to send vedding presents.

5 Stoichiometry: Study of the numerical proportions in which substances react chemically.

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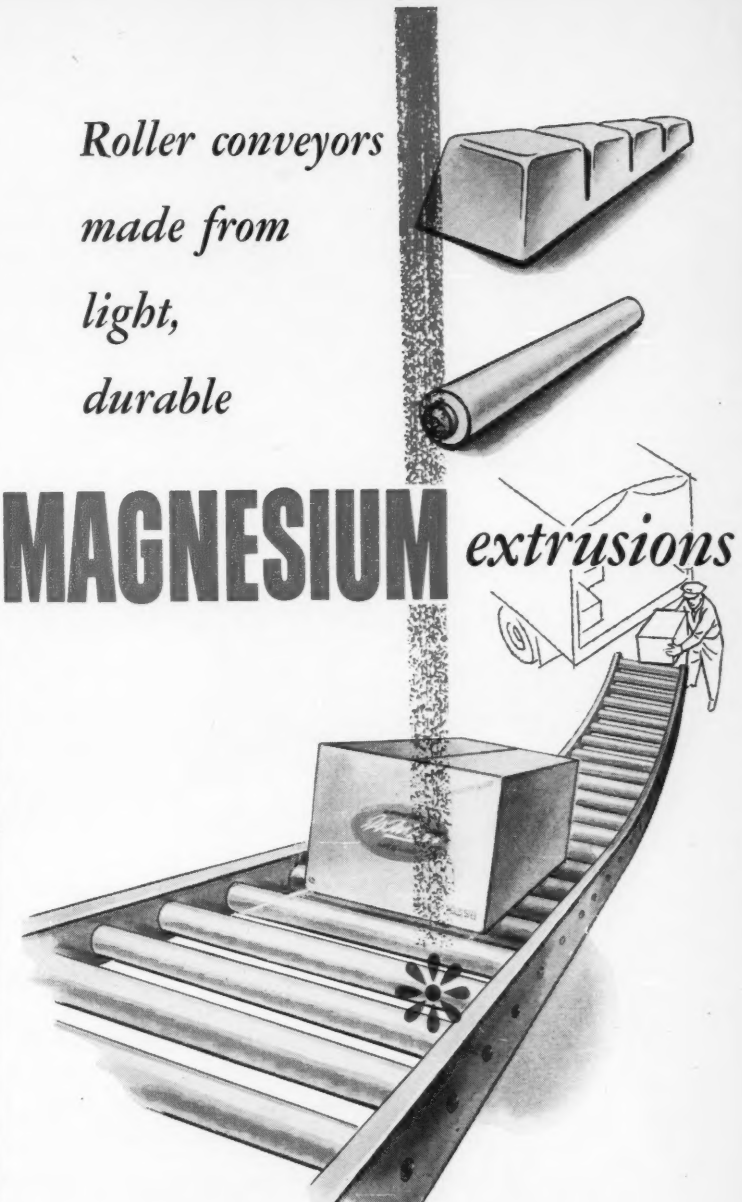

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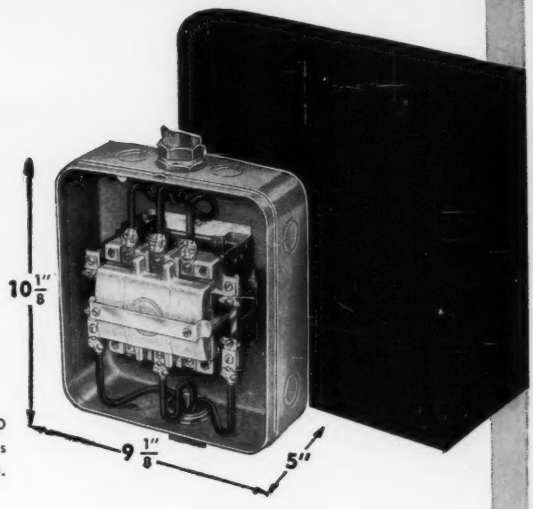

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Dr. Moses' early-man teeth

Teeth Should Wear

TORONTO DENTIST, Dr. Charles Moses, spoke to 15,000 brother dentists at a recent New York forum and made bigger news than he expected.

With scientific caution, he talked about new thoughts on false teeth design and the long research that led to them.

His listeners, absorbed in the broad problems of dentistry, took the account calmly. But to a reporter among them it seemed like a call to action.

Taking the doctor's science, he detached the caution and sent a story quickly on its way. Editors were receptive, many papers gave it space.

Interest settled on a quote alleged to have been made by the doctor which claimed that the new teeth chewed steak like tenderized meat. Dr. Moses, although sure that his teeth are an improvement on most, was embarrassed. "I made no such comment," he said. "The reports weren't accurate at all."

False teeth are usually made with cusps (bumps) on the chewing surfaces modelled on natural teeth. But Dr. Moses, working with Canada's famed dental researcher Dr. H. K. Box, found that natural teeth were less natural than they seem. Primitive man, for instance, had flat teeth. He wore away his cusps on the hard foods in his day without losing any of the bite in his chew.

This gave a better direction to the chewing forces and a better distribution of pressure. Dr. Box (who is a professor at Toronto university) noted that where cusps were prominent, the socket bone was less robust and pyorrhea was more common. A new way of thinking about teeth had begun.

Dr. Moses took the thinking further by long researches into many hundred human and animal skulls. He confirmed that wear on teeth is normal, that it is lack of wear which is abnormal. He also pointed out that the slope of primitive man's teeth was not the same as modern man's and that again it was primitive man who had the advantage. Slope affects chewing power and early man's slope was better matched to a chewing motion.

Dr. Moses suggested that dentists were wrong to imitate civilized man's teeth, that it would be better to model them on the aborigine who is especially well equipped to tear fibrous foods.

Aborigines wear the enamel through to the softer dentine underneath which then cups-out to form food escapes. Sharp enamel edges remain and act as knives.

In the new teeth by Dr. Moses, the enamel edges have been replaced by hard gold inserts and the food escapes by softer methyl methacrylate plastics. They can be cast by any dentist in his own office and are better chewers than conventional false teeth. That is the limit of the claim.

Jet Engines

(Continued from page 74)

our government research stations. The problem now is how to produce them in quantity.

In most present-day turbo-jets, air is the chief cooling agent. But when supersonic speed makes it too hot, lubricants will have to act as coolers. They too will need cooling probably (as at present) by having the fuel flow to the engine through an inter-cooler. The next difficulty will be that in some flight conditions even the fuel will not be a big enough sink to get rid of excess heat and something else will have to be thought up to keep the lubricants safely cool.

Bearing steels have been made which stay hard at temperatures up to about 550 deg. C, but we have no lubricants yet that will stand that heat. It is all quite difficult. Synthetic lubricants exist which will work up to 200 deg. and somehow they must soon be improved to stand at least 350.

Lubrication is such a serious problem that it could be the most limiting factor facing designers of supersonic aero-engines.

And the elastomer compounds for O-rings and gaskets (the other main non-metallic part in gas turbines) are quickly reaching their heat limits. Present silicone rubbers and fluorinated polyethylenes work up to about 300 deg. C. Here again temperatures will be going up—to about 500 deg. in this position.

To get the high air flow of the future engine, the can type of combustion chamber will probably give way to the annular type—which allows a bigger gas passage in the same engine diameter. But it will take much development work to build units which work well at temperatures and gas velocities well above the 1,100 deg. K† and 80 ft. to 90 ft. per second of today.

Until the time comes when combustion of fuel near the stoichiometric‡ limit in front of the turbine is possible, an after-burner may have to be used to boost engine thrust for combat, acceleration and climb. Keeping this unit light, simple to manufacture and service, yet able to burn fuel at 2,000 deg. K (and more) will not be easy. It should have a fully modulated adjustable final nozzle and the control and fuel systems should be hooked up with those of the main engine to form a single control.

The big engines of the future, swallowing great amounts of air will need high fuel flows. Normal gear or piston fuel pumps would need to be immense to handle them. They might be designed to work at higher speeds, or the air-driven centrifugal pump being developed for after-burners might be used. It is a big problem. Pumping capacities of 30,000 lb. to 60,000 lb. of fuel per hour will be needed. And this explains why the search for fuels with bigger heating values than 18,000 Btu per lb. of the normal hydro-carbons is so intense.

Then, engines are going to have to be matched to aircraft types. In fact, the days of the universal engine are very nearly behind us already.

Control systems, too, look like getting terribly complex in the future. They will have to control fuel flow for different speeds and altitudes; they will have to protect rotors from overspeed, turbines from overheating and so on.

Unless design simplicity is fought for stubbornly a hopeless confusion will soon be on us. Visualize the maze of gear which almost covers the outside of most turbo-jets and you will see this confusion coming.

It is the accessories that keep aircraft grounded—the valves, filters and solenoids, the tremendous trifles as they could be called.

Mr. Abe Silverstein, associate director of Lewis Flight Laboratory, showed recenty that the weight of an engine and its fuel accounts for about 25% of the weight of an aircraft designed to fly at Mach .5. But this becomes 60% for an aircraft which can reach Mach 1.5. Here then, lies the need for this new outlook—the belief in simplicity.

Designers must see that complexity is the easy way, that every part discarded is one less to cause trouble. There is tomorrow's challenge.

†To degrees centigrade, add 273 for degrees Kelvin.

‡The point at which all oxygen is burned.

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Design news in pictures

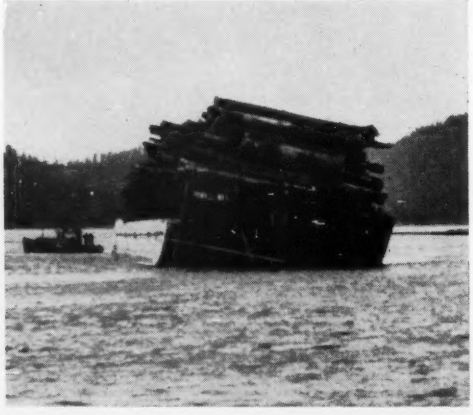
Some modern designs making news today

Chief Fire Officer J. A. Broadbent in Wiltshire, England, invented this haystack cutter to help fight stack fires. A 1-kv gas driven generator drives a hammer fitted with a special-design blade. Unburned hay is cut into chunks then hauled away. The whole assembly was made by Kango Electric Hammers for the county brigade.

This factory-made barn by ex-Montrealer Jeffrey Lindsay might transform future homes. Mass-made houses should "look industrial," he says, "—which need not mean ugly."

A design engineer's wrist watch was on view at this year's Basle watch fair. Made in Switzerland, it combines a dial type slide rule with time-telling on its clean looking face.

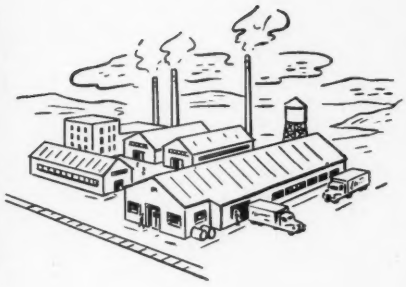
The 1,500,000 ft. of logs on this new Powell River barge unloads in 10 minutes — an immense saving of time and cost. The barge is towed to position, four 8 in. port side valves are opened and this happens. The flooding tanks then self-bail to right the barge after dumping. Burrard Drydock (Vancouver) built it, are at work on a second one.

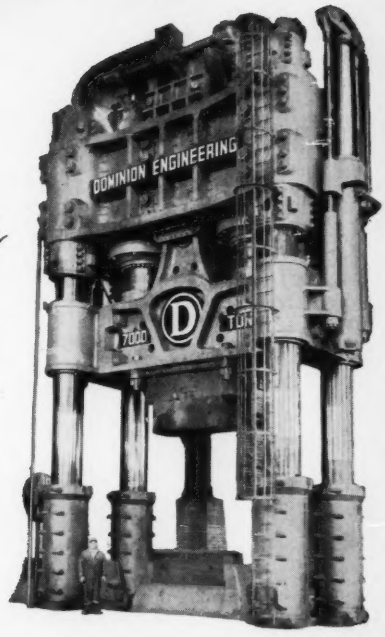


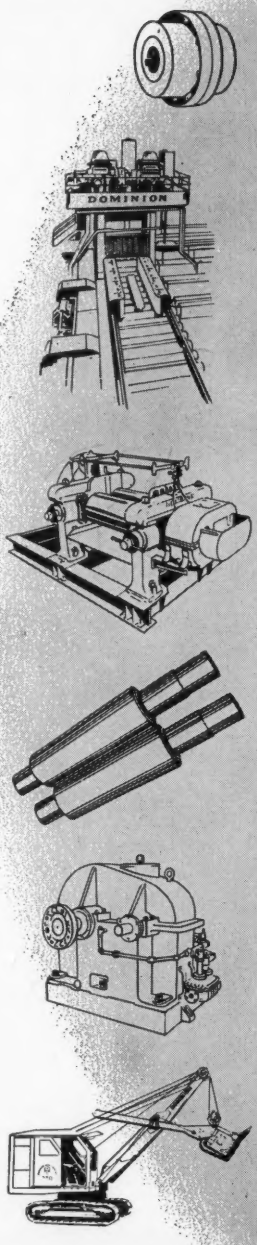
In Canada's heavy industry

DOMINION

plays a major role







DESIGNED, manufactured and installed by Dominion Engineering Company Limited, this 7,000 ton hydraulic forging press typifies Dominion's operations in the supply of heavy machines for industry. These include rolls, rolling mills, and machines for the production of rubber and plastics. The manufacture of transmission equipment and power cranes and shovels also forms a substantial part of Dominion's business. In addition, machinery for the pulp and paper industry, for mines and for hydro systems, carries the Dominion name to all parts of Canada and throughout the world.

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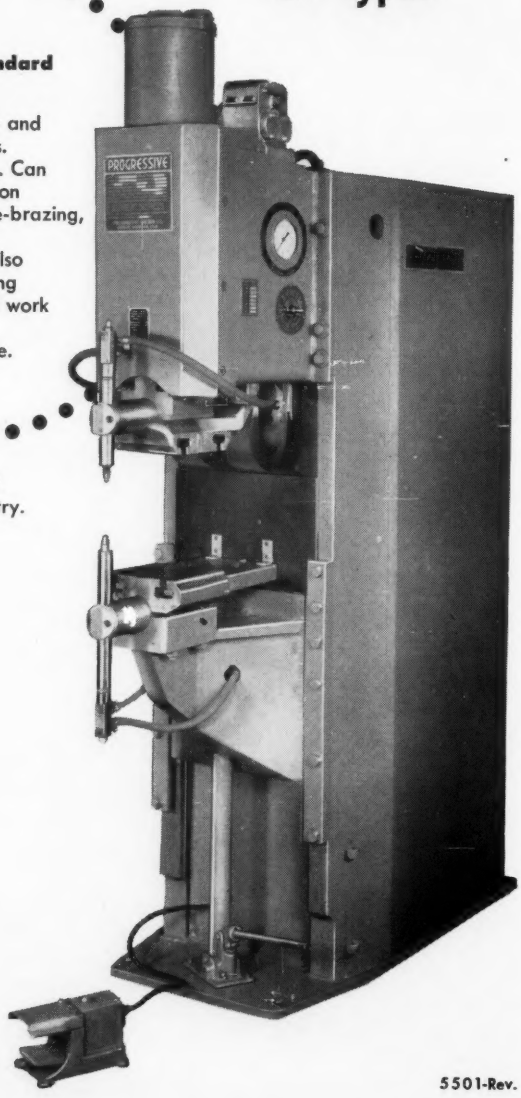

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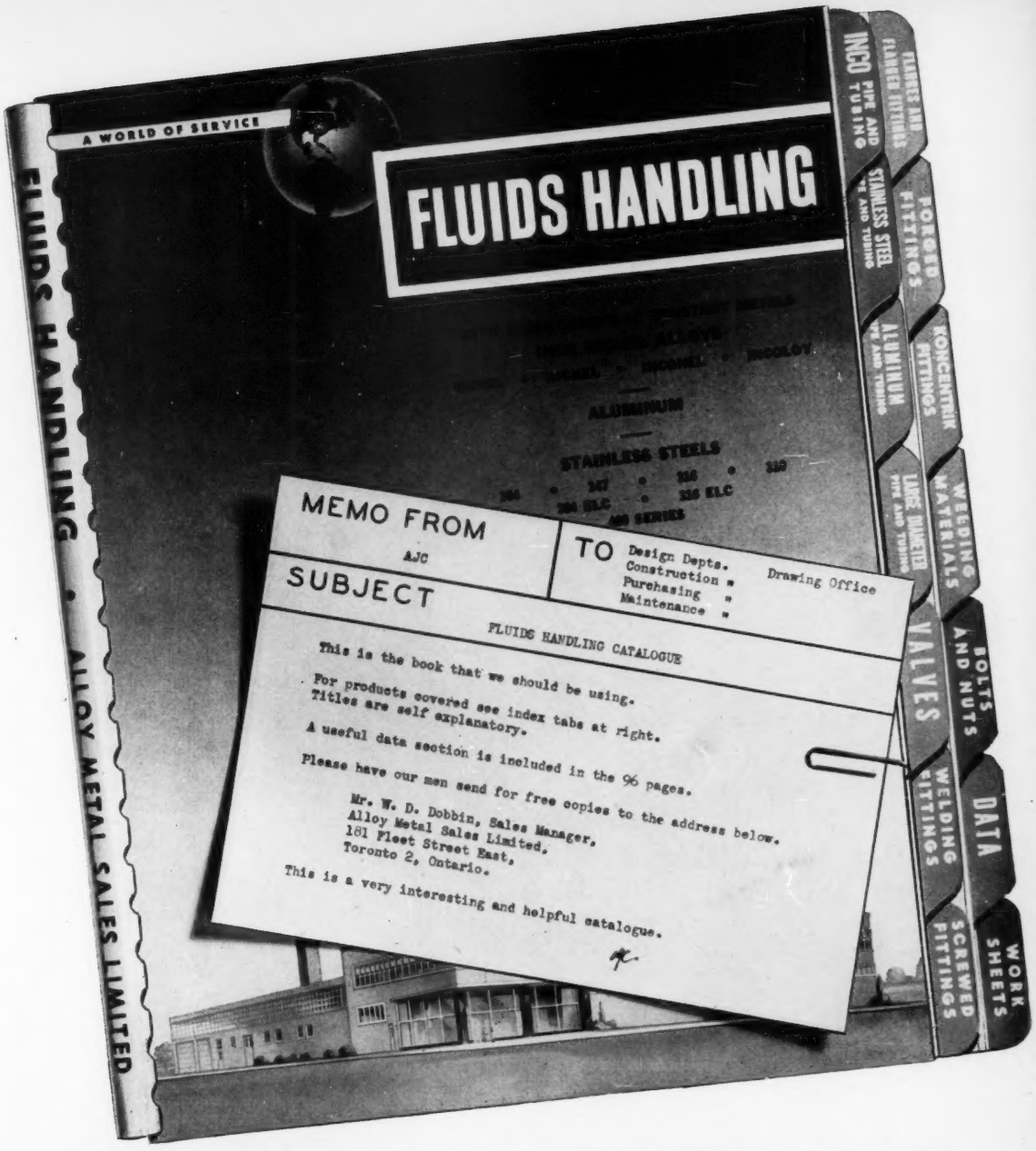

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File

New booklets and books written for you

IN A BROCHURE on Adhesives, Coatings and Sealers, the **Armstrong Cork Company** gives information in two sections. The first of these includes the choice of the right adhesive, designing joints for adhesives, practical examples of design improvement and testing. The second group shows the basic types of adhesives such as synthetic rubber, reclaim rubber, natural rubber, oleoresin and water base and gives a useful chart showing the resistance of dry film to liquids, temperature and weather conditions.

The brochure is very well produced: it would be even better if there were a general contents page at the beginning of the book (208)

• • •

A NEW CATALOGUE B-39 deals with Formbrite, a metal with a superfine grain structure, high tensile strength, hardness and ductility and well suited when good polishing and finishing is wanted. It is being put out by the **American Brass Company.** It is available as sheet and strip for pressroom products and as wire for cold heading and upsetting.

Notes are given in the brochure for getting the most out of the material. Formbrite has been used in making a well-known fountain pen. (209)

• • •

CURRENT BULLETIN 4208 of the **Baldwin-Lima-Hamilton Corp.,** deals with a line of creep testing machines.

Creep is, of course, the dimension change in relation to stress, temperature and time.

A metal does not necessarily behave in the same way at high temperature as it does at low temperature. These machines have, therefore, been designed to carry out the four main high temperature creep tests. The long-time creep test, short-time creep rupture test, relaxation test and constant strain rate test. (210)

• • •

ENGINEERING PROPERTIES and uses of Ni-Hard are treated in a brochure of the **International Nickel Co. Inc.** Ni-Hard is the trade name for a nickel-chromium white cast iron with good abrasion resistance. It is not a new alloy; it has been used for some 25 years in the mining, power, steel and paint industries for such typical work as grinding balls, mill liners, metal working rolls and so forth. The brochure is divided into two main parts. The first deals with engineering properties—abrasion resistance, hardness, machining and the like. The second shows the uses in some detail by means of photographs and descriptive text. (211)

• • •

AN AUTOMATIC CLUTCH, centrifugal type, is described in a new catalogue being put out by the **BLM Clutch Corp. of Canada.** The clutch is designed to transmit power in such a way that the prime-mover cannot be overloaded during starting or running.

This is done by using a mechanism the power output of which depends on centrifugal force, and hence speed; a unit fitted with such a clutch must start under no-load conditions.

The application of a torque (or horsepower) greater than that for which a particular clutch has been designed at a given speed automatically causes clutch slip. There is thus no fear of overloading the prime mover.

BLM clutches have been used successfully for many years with electric motors, gasoline and diesel engines . (212)

• • •

QUESTIONS AND ANSWERS about "welding aluminum" is the title of a brochure published by the **Aluminum Co. of Canada Limited.** It gives general information on argon tungsten arc, inert metal arc and oxy-gas welding and the brazing of aluminum and its alloys, in a form useful to company executives and welding personnel. Topics discussed include characteristics of these processes, weld properties, safety practices in production, production examples and equipment. (213)

• • •

A NEW STEEL, Carilloy T-1, is being made known to engineers through a booklet offered by **United States Steel.** Carilloy has been developed to meet the need for a weldable steel, primarily in plate form, having a very high yield strength (90,000 psi or more) and able to take pressure and shock loads at low or high temperature.

Tests have been carried out to destruction on four full-size, cylindrical pressure vessels built entirely of ½-in.-thick T-1 steel plate. The vessels tested were of 4 ft. diameter and 20 ft. long with welded hemispherical heads.

Two of the vessels, whilst refrigerated to minus 50 F, underwent internal hydraulic pressure until they finally burst. The other two, refrigerated to minus 45 F, and under a pressure of 1,875 psi, were subjected to repeated impact. In each test, one vessel of each pair was stress-relieved and one was tested in the as welded condition to show that stress-relieving is not necessary even though welding is involved.

In the pressure tests, each vessel before it burst withstood hydraulic pressures up to 2,850 psi—equal to a stress in the shell plates of more than 136,000 psi. In the impact tests, an ingot of steel weighing over 13 tons was dropped successively on each vessel from 52 ft. and 73 ft. From the 73-ft. drop alone, the vessels withstood nearly 2 million ft. lb. of energy without rupturing. It required, in fact, 2,700,000 ft. lb. additional energy (a drop of 101 ft.) to rupture both vessels.

In all four tests, when rupture finally occurred, it did so in a completely ductile manner. The welds were intact and no shattering occurred. The steel simply tore open with no pieces breaking loose from the vessel.

If these vessels had been made of conventional ASTM A-201 Grade B carbon steel, they would have had to be about 1½ in. thick and so three times as heavy. On the other hand, had they been made of conventional carbon steel ½ in. thick, they would have withstood only about 1,150 psi or less than half that of the T-1 vessels before failing. (214)

• • •

Book Department

Metals Engineering—Design

THIS HANDBOOK by the ASME, the first of a projected four, is for the design engineer. More than 40 authors put it together and the galaxy of talent includes such eminent people as **Timoshenko, Frocht** and **Wojtaszak.** The book is divided into six parts, each with its own bibliography.

A short review cannot do justice to the book; one would have to live with it almost daily to do this.

It is very well produced on good paper with clear, sharp illustrations. The first section deals with the selection of materials and is followed by a review of high temperature effects, plasticity, vibration and cold working. Part three goes broadly into corrosion and part four gives a digest of non-destructive testing, like ultrasonics (see feature in this issue), magnetic particle inspection, X-Ray and so on. The last two sections discuss mass production and theories of failure, strain gauges and photo-elasticity.

A number of engineers will disagree with the nomenclature used in some places—particularly the use of Y (instead of E) for Young's modulus and μ (instead of G) for shear modulus. But this whole business of nomenclature is due for a springclean at International level.

Metals engineering—design is recommended as a useful tool. (215)

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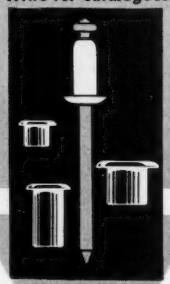

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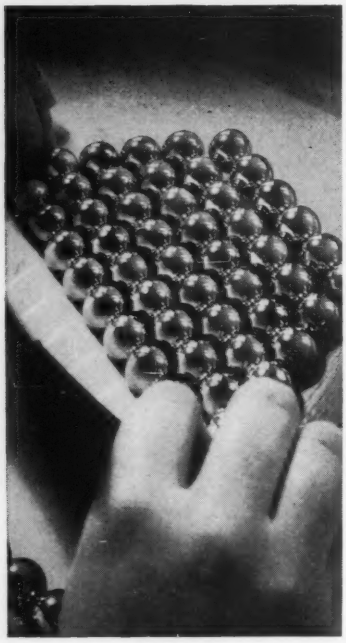

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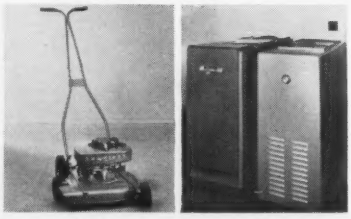
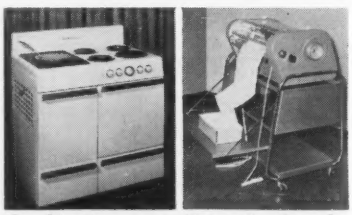
NIDC Makes its 1955 Awards

Canadian products have won 83 awards for 1955. Some typical winners are shown here



Mower, left, Brooks Stevens and Outboard Marine (Peterborough). Furnaces by Bersudsky and Gen. Steel Wares (Toronto).

Airfoam daybed, Robin Bush (Vanc.)



Combination range, Enterprise Foundry Ltd. (Sackville, N.B.) Imprinter and stand, by R. L. Crain Ltd. (Ottawa).

THE SEVEN YEAR old National Industrial Design Council has announced its 1955 design awards. This is the third time that annual awards have been given for what the council describes as the year's "outstanding designs."

Each month throughout the past year, a preliminary "rating committee" has been meeting to examine newly designed products as they are submitted by manufacturers. All those that the committee approved were sent on for the final opinion of five eminent design award judges.

The jury used five tests for its selection: form, function, originality, good value and consumer acceptance. Each member had specialized knowledge to bring to jury meetings. The judges were: Jean M. Raymond, vice-chairman, NIDC, J. D. Ferguson, president, Canadian Manufacturers Association, John Bland, director of McGill University's school of architecture, Mark Ely, president, Canadian Retail Federation and Mrs. John Butterfield, consumer research chairman for the Canadian Association of Consumers.

Eighty-three awards were given to designers and manufacturers throughout Canada. A presentation ceremony was held March 14 in Ottawa and presided over by the Rt. Hon. C. D. Howe and the Hon. J. W. Pickersgill. The winning products are now going on view in Ottawa, Montreal and Toronto. NIDC believes these awards are an important part of their work in promoting the use of Canadian design talent in all kinds of consumer goods.

The council began as a small committee in 1948 and grew quickly to its present size of 20 members representing manufacturing, retailing, industrial design, research and education groups. It is financed by the Government but has some of its competitions paid for by industry. Its chairman is always a manufacturer — currently, Donald B. Strudley, president of the Imperial Furniture Manufacturing Co.

The council will always help any group anxious to improve design standards in Canadian products and is dedicated to bringing forward design talent wherever it can. It puts out persuasive booklets and pamphlets and is now at work on a motion picture for wide distribution.

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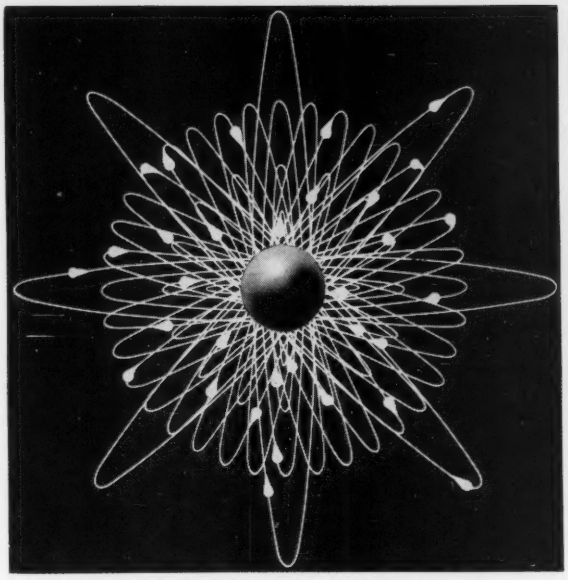

Electronics in May. The flower like Germanium atom plays a growing part in transistors . . . read about it in May Design Engineering.

Product engineers will also want to read these other exclusive articles in the May issue of

Design Engineering

Torsional vibrations. The lead feature tells you how to work out torque vibrations in piston engines. Some high-compression engines run so rough that shafts break, gears strip and foundations crumble. This article shows you how to design smooth running engines every time.

Silicones make news again. Why put sand in your bearings? Because it will give you longer bearing life—if you use the right sand! Here is a widely researched article which takes a modern look at lubrication to keep you in touch with progress.

An automatic welding process is taking hold of Canadian industry. It is a production method of the future. May's DESIGN ENGINEERING will bring you up to date on this big step forward.

Titanium keeps coming. Editor William Morse looks at one of industry's newest metals, assesses its value and future. This too, is in the May issue.

Four other full length features will also run — each with its own important message to Design Engineers. And the nine regular news sections will still be there, in May's DESIGN ENGINEERING.

Make sure you get the May issue . . . use the special offer subscription card in this issue!

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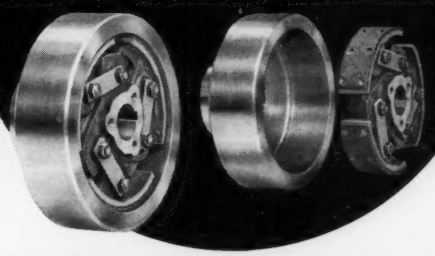

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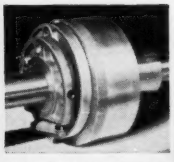
- Let Our Engineers Consider Your Problem. Twiflex May Be The Answer.



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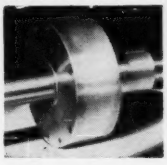
Write for Bulletin 239.

OVER-RUNNING CLUTCH

For automatic engagement and release on two speed drives, dual drives and for ratchet feed or backstop action.

Write for Bulletin 231.



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Letters

Your views influence Canada's industry

● I was pleased to learn from your letter of your decision to bring to the engineering profession in Canada, a magazine which will afford a new and convenient means of keeping abreast of the latest developments in engineering design in the diversified fields which you propose to cover.

I congratulate you on a move which I am sure will be welcomed by all engineers concerned in design and wish you every success in your efforts.

C. D. HOWE

Ottawa *Minister of Defense Production*

● As an American engineer now living in Canada (the fishing is very good here) I would like to congratulate you on your courage in coming out with your new magazine. It seems to me to be an act of brave folly!

Canadians are very fine people but are not, as far as I can see, product designers. Most designs are taken straight from the U. S. and it becomes just a matter of minor modifications for Canadian engineers.

Still the position may change and if you think you can produce the magazine I think I can afford to buy it. So put me on the list please.

Montreal, Que. DON GOZZARD

Subscriber Gozzard will be seeing further. Long research preceded the birth of DESIGN ENGINEERING and showed that much unsung original design does go on in Canadian industry.—Ed.

● I was most interested to hear about your new magazine DESIGN ENGINEERING. At long last Canadian endeavours in the field of product engineering and design will be recognized.

Product engineers in Canada, I am sure, will find the exchange of knowledge and experience in applied research, design data, and production methods most stimulating and broadening. This function is, I understand, the aim of DESIGN ENGINEERING — and I wish you every success.

Looking forward to my first issue . . .

J. D. ORR,
Consulting Engineer

Toronto

● The instability of production programs in Canadian engineering industries is serious. Poor continuity of production affects everyone—and yet no-one seems to be doing anything to put it right.

It is true that weather and seasonal marketings are partly the cause. But the habit of producing huge amounts of a particular product (to get ahead of competition) is one of the causes too.

Why do we not plan our flow better by producing a number of varied products concurrently so that when the market falters for one, production can be geared up for the others? If it will take more versatile machine tools to do this—well, let's have them. The repeated shut downs and fluctuations in our industries today, cause grave concern to management and employees alike. And some intelligent action should be taken.

At least we could be putting more energetic research into this part of product engineering. What editorial interest is DESIGN ENGINEERING going to take in this problem?

JOHN SAVILE
Consulting Engineer

Toronto.

DESIGN ENGINEERING will show interest in this and all other product engineering problems.—Ed.

● I am very pleased to hear that a magazine called DESIGN ENGINEERING is going to be published by Maclean-Hunter.

It would appear that this publication will fill a long-felt want and . . . I believe it will be a worthy addition to the Canadian technical press. It should be of real value to professional engineers in Canada.

W. A. WATTS

Toronto *Chief Engineer, Can. Div. Massey Harris Ferguson*

● The publishers of DESIGN ENGINEERING are to be congratulated for their foresight and initiative in launching a technical periodical catering to the needs and interests of this still small but important field of Canadian engineering.

Although Canada has produced a great deal of outstanding design engineering talent, it is only in recent years that significant opportunities have begun to develop for it.

But with our ever expanding industrial economy, and under the stimulus of successes achieved by those Canadian companies who pioneered creative engineering, a broadening horizon lies before design engineers in Canada.

Your new publication is an act of confidence in this growing branch of engineering art. I should like to be among the first to offer congratulations —and best wishes for success.

PAUL B. DILWORTH
P. Eng.

Toronto.

● There is design work going on in western Canada which is no less important than the progress in the east. I hope DESIGN ENGINEERING does not forget this. If it does, there are some westerners who will probably decide to forget DESIGN ENGINEERING. I will be one! In the meantime, best wishes for your success.

T. D. VOGEL,
Staff Designer

Vancouver

DESIGN ENGINEERING is a national magazine. Designer Vogel may be sure it does not regard the west as less (or more) important than the east.—Ed.

● The birth of a Canadian magazine specially dedicated to Canadian design engineering—this is indeed a happy event; a recognition of the growing importance of our home-grown research and development.

But Canadian industry has far to go toward original and creative engineering based on our own special needs. DESIGN ENGINEERING can help us forward, stimulating each separate enterprise by keeping the whole pattern of our progress visible before us.

ROY JACKSON,
Ridout and Maybee
Patent Attorneys

Toronto.

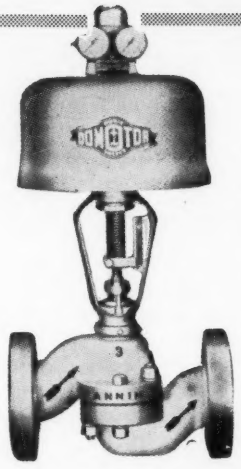
● Congratulations for your courage and enterprise in initiating the new periodical. There is a gap in the Canadian field for this type of publication. Although the standard set by U. S. publishers is high and the competition keen, I am sure that we Canadians have shown enough originality and ingenuity in the field covered by DESIGN ENGINEERING to give support to a well conceived effort.

I wish you the best success . . . we shall certainly take advantage of your invitation to contribute.

J. W. MILLER,
Miller Naismith,
Engineering Consultants

Toronto.

QUALITY EQUIPMENT FOR CANADIAN DESIGN ENGINEERS



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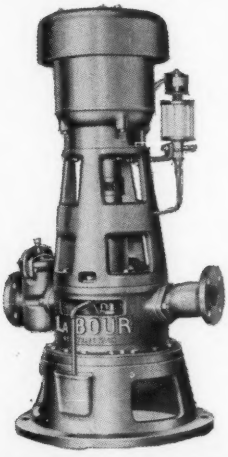

The DESIGN ENGINEER would do well to invite Kirk Equipment to provide detailed information on the various lines handled by them.

These include Dean-Hill Steam Turbines, Kraissl Strainers, Hoke Valves & Fittings, Warren Pumps, Panellit Control Panels & Panalarm Annunciator Systems.

Watch for additional depicted ads in this journal.

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Our advertising salesmen work on a generous salary plus commission basis. Our company also makes substantial contributions to hospitalization, life insurance and pension plans.

We offer most attractive careers. All of our publication managers and other senior executives started their careers with us in a junior capacity, some even as messenger boys. Every member of our staff has the same opportunity to reach the top if he has ability matching his ambitions.

What have YOU to offer?

Why not write and tell us about yourself, your experience, education, age, marital status—and your ambitions. Better still, if you happen to be in Toronto at any time, drop in and see us.

We shall, of course, respect your confidence.

B. A. Lawless, Personnel Manager,
MACLEAN-HUNTER PUBLISHING COMPANY LIMITED
481 University Avenue, Toronto 2
EMpire 3-5981, local 208.

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From the ENGINEERING
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Component parts or complete products—perhaps they can be made faster, better, less expensively of PLASTIC! If they can, French Ivory can tell you so. Designers, engineers, purchasing agents are invited to inquire without obligation.

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Editorial

Design Engineers And the Next Hundred Years

WHAT DO YOU SUPPOSE the editors of **Design Engineering** will be reporting 100 years from now? Will the biggest engineering brains and projects be Canadian in 2055? They should be; perhaps they will be. But it does not follow.

Eighteen months ago, a senior draftsman's health broke down and sent him south to Arizona. He found more than sunshine there. He was hired at once by a large manufacturing company and then promoted in giant bounds. In twelve months he became chief design engineer; the Americans saw he had ability — enough to be top man — yet, if he had stayed at home he would have stayed a draftsman. Canadian engineers have talent, but most of it is used to modify foreign products. There is still too little scope for creative design. Why?

Paul Dilworth, "father" of the Orenda and perhaps Canada's best-known design engineer, has given a simple explanation and a warning: "We under-rate our own creative work. We seem to overlook that this is the way to lose control of our own industries."

Of course he is right. If we do not finance development work, we cannot compete for trade; if we cannot compete we can be broken—or bought—by foreign business. It is as simple, as serious, as that.

The long hunt for facts that preceded the start of **Design Engineering** showed that the position is changing. The aircraft industry is busy with top-grade developing; some of our electrical companies are nourishing creative projects; and there are many other signs. But the change is too slow! Canada is an industrial nation, a big producer and a big consumer, enslaved by too many licenses; industry under license is industry in chains.

Big efforts must be made to free us from dependence. Development work is a political lemon. It is costly and slow —but it is also necessary; here is a case where politics are not admissible. Why not tax relief for development costs? Why not broader defense contracts with more money for research, fewer demands for production-at-once?

And what of management? It must learn that sometimes you spend money to make it; that the quickest deal may put a dollar in your pocket today but a gun at your head tomorrow.

Then, besides all this, there is a critical need for news. Canadian design engineers have never before had their own broad publication to give them the selective service they need. It has come now—as it had to. It has just one interest, the promotion of creative engineering at home —of your interests which are also Canada's. Its editors hope you like the first issue and that future ones grow better until (at least) April 2055.

Blow Press Limited says:

"TIMKEN bearings last up to four times longer, reduce clutch maintenance"

AFTER using Timken tapered roller bearings for 15 years on the flywheel of its Open Back Inclinable Punch Press, Blow Press reports that Timken bearings "last up to four times as long as bronze bushings", require "much less clutch maintenance, less bearing maintenance". Timken bearings eliminate the biggest cause of clutch trouble—loose or worn flywheels. Blow Press also pointed to another big advantage: the "sales appeal of Timken bearings".

Flywheels are kept in accurate alignment because the tapered design of Timken bearings enables them to take radial, thrust and combination loads. Flywheels do not become worn or loose. Clutch trouble is eliminated before it can start. Crankshaft wear is prevented.

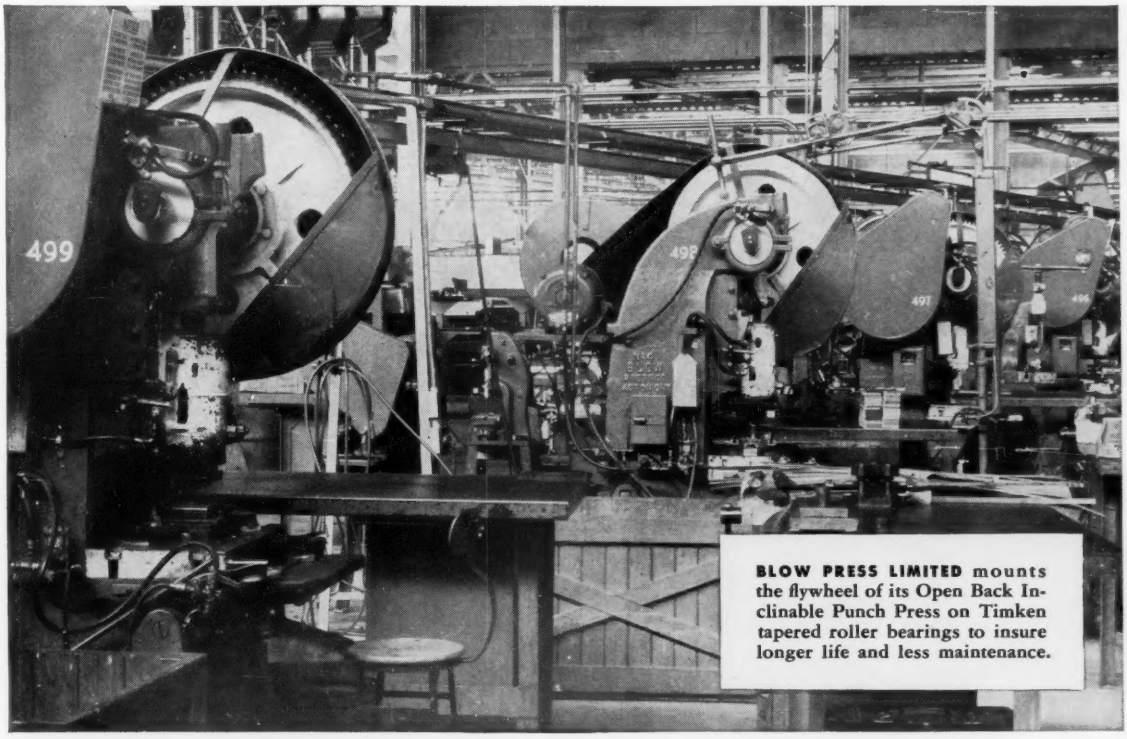
Power loss is kept to a minimum in Blow Press punch presses because the true rolling motion and smooth surface finish of Timken bearings practically eliminate friction. And by holding housings and shafts concentric, Timken bearings make closures more effective. Lubricant stays in—dirt stays out.

Be sure to specify Timken bearings for all the machinery you build or buy. They give longer life with minimum maintenance. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

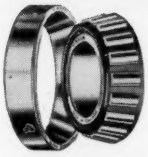
CANADIAN PLANT: St. Thomas, Ontario.

U.S. PLANTS: Bucyrus, Canton, Columbus, Mt. Vernon, New Philadelphia, Wooster and Zanesville, Ohio; Colorado Springs, Colorado.

TIMKEN BEARING EQUIPPED — *This symbol on a product means its bearings are the best*



BLOW PRESS LIMITED mounts the flywheel of its Open Back Inclinable Punch Press on Timken tapered roller bearings to insure longer life and less maintenance.



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TAPERED ROLLER BEARINGS

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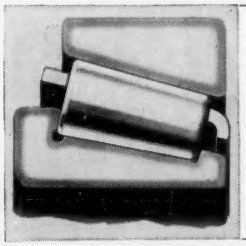
BEARING TAKES RADIAL ↓ AND THRUST →◎← LOADS OR ANY COMBINATION →◎←



HARD ON THE OUTSIDE, TOUGH ON THE INSIDE

Rollers and races of Timken bearings are case-carburized to give a hard, wear-resisting surface and a tough, shock-resisting core. Result: longer bearing life.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

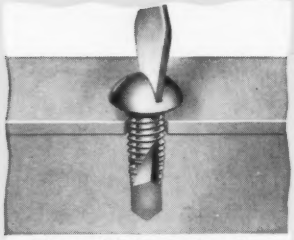
MADE IN CANADA FOR CANADIAN INDUSTRY

Why

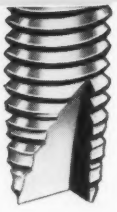
SHAKEPROOF® THREAD-CUTTING SCREWS

give a better fastening... faster!

Shakeproof Thread-Cutting Screws offer you immediate assembly savings.

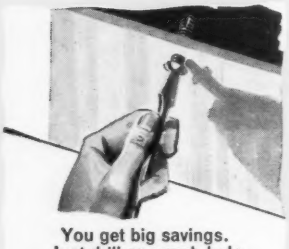


They cut their own threads, eliminate separate tapping operations completely.

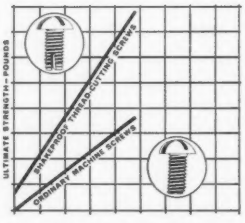


This thread-cutting slot exposes a sharp, serrated cutting edge.

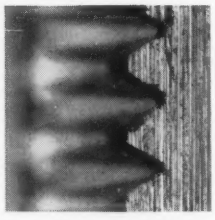
Shakeproof Thread-Cutting Screws actually work with true tapping action.



You get big savings. Just drill or punch hole and drive—that's all! No tapping, no tapping tools!

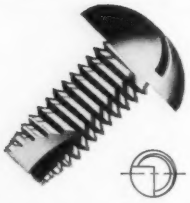


These hardened screws provide greater strength . . . often permit use of smaller sizes.

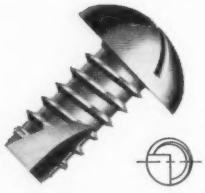


Self-cut mating threads assure a tight, vibration resistant fit.

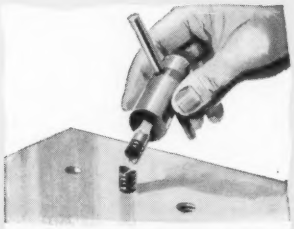
Type 1 Thread-Cutting Screws are specially designed for use in hard metals.



Type 23, with wider thread-cutting slot, is for use in metals and plastics.



Type 25, with spaced thread, is designed for use with plastic materials.



Eliminate costly taps and tapping . . . improve quality and cut costs at the same time.

Every screw is a cost saver when you specify Shakeproof Thread-Cutting Screws.

Free Sample Kit

Now . . . make your own tests! See for yourself how Shakeproof Thread-Cutting Screws can save money in your plant. Write for your free sample kit today!

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